

**EPA Superfund  
Record of Decision:**

**MILAN ARMY AMMUNITION PLANT  
EPA ID: TN0210020582  
OU 10, 11, 12, 15  
MILAN, TN  
03/11/1998**

EPA 541-R98-020

<IMG SRC 98020>

<IMG SRC 98020A>

4WD-FFB

Lieutenant Colonel Billy J. Dowdy  
Commanding Officer  
ATTN: SMCMI-IO (200-1a)  
Milan Army Ammunition Plant  
Milan, Tennessee 38358-5000

SUBJ: No Action Record of Decision  
Milan Army Ammunition Plant, T-N, NPL Site

Dear Lt. Col. Dowdy:

The U.S. Environmental Protection Agency (EPA) has reviewed the No Action Record of Decision pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Re-authorization Act of 1986. EPA concurs with the finding and selected remedy presented in the No Action Record of Decision for the Salvage Yard, Former Ammunition Burnout Area and Landfill Operable Units (OU).

If you have any questions regarding this action, please contact me at (404)562-8651 or my staff. Pete Dao, at (404) 562-8508.

<IMG SRC 98020B>

<IMG SRC 98020C>

STATE OF TENNESSEE  
DEPARTMENT OF ENVIRONMENTAL AND CONSERVATION  
DIVISION OF SUPERFUND  
4th Floor, L&C Annex  
401 Church Street  
Nashville, TN 37243-1538

February 10, 1998

LTC Billy J. Dowdy  
U.S. Army Commanding Officer  
Milan Army Ammunition Plant  
Milan, TN 38358-5000

REF: 27505 MLAAP Site, No Further Action Record of Decision (ROD) January, 1998

Attention: Mr. Patrick Brew, SMCIO

Dear Colonel Dowdy:

The Tennessee Department of Environment and Conservation (TDEQ) received the final Record of Decision For No Further Action at the following areas of concern at MLAAP Landfill, Salvage Yard, and the Former Ammunition Burnout Area. The Department concurs with the findings of the report and the recommendation of no further action at the areas listed in the ROD.

If you should have any questions regarding this matter, please contact me at (615)532-0227 or Ron Sells, Manager, Jackson Field Office at (901) 661-6204

<IMG SRC 98020D>

<IMG SRC 98020F>

**Milan Army Ammunition Plant**  
**Operable Units 10, 11, 12**  
**No Action ROD, Jan 1998**

**Background:**

Operable Unit 10 is a 15 acres Former Burnout Area that was in operation from 1945 until the 1950s. Disassembly and burnout of ordnance items occurred within concrete pad areas at this OU. Currently, it is being used as a pistol firing range.

Operable Unit 11 is 41 acres landfill currently permitted under the State of Tennessee Solid Waste Regulation. It has been in use since the 1960s. Rubbish from industrial operation, consisting of paper, shipping containers, cardboard boxes, and filter pads, were placed in trenches and covered with soil.

Operable Unit 12 is a 4.6 acres Salvage Yard with an unknown date for original start of usage. It is currently still in use for the storage of salvageable scrap metal including casing, machinery and wood.

**Remedial Investigation and Risk Assessment Results:**

Operable unit 10 detected metals in soil and sediment above background and RBC screening levels for arsenic, barium thallium, beryllium, chromium, iron, vanadium and manganese. Groundwater constituent exceeded RBC for beryllium, cadmium, chromium, bis-2 ethylhexyl phthalate and 1, 3,5-trinitrobenzene.

A risk assessment was performed for these constituents. A  $4.2 \times 10^{-5}$  risk and 0.71 HI were calculated for potable ground water use. Risk associated with soil exposure resulted in a  $2 \times 10^{-5}$  and a 1.9 HI. Thallium contributed most to the HI but it has an uncertainty factor of 3000.

OU 11 groundwater exceeded RBC for bis-2-ethylhexyl phthalate, 1, 3,5-trinitrobenzene, RDX, 2,4,6-TNT, chloroform, beryllium, and cadmium. No soil exceeded background or RBC.

A  $1.2 \times 10^{-4}$  risk and 0.23 HI for groundwater were obtained, with beryllium contributing  $9.6 \times 10^{-5}$  to the total. Highest level for beryllium was 1.54 Ig/L. The MCL is 4 Ig/L. The soil does not pose any risk.

OU 12 groundwater did not exceed any background or RBC. Soil exceeded background and RBC for thallium, beryllium, copper, cadmium, chromium, iron, lead, and zinc.

The cumulative risk of  $1.1 \times 10^{-5}$  and a 13 HI was calculated with 4.2 HQ for copper, 2 HQ for Iron and 4 HQ for Thallium. There is a high uncertainty associated with copper because the RfD was back calculated from MCLG for copper in drinking water. Iron and thallium have a 1,000 and 3,000 uncertainty factor applied to the toxicity value.

None of the OUs pose a threat to ecological receptor.

**Recommended Remedy:**

No Action is recommended for all three OUs base on the low potential for unacceptable risk.

**Public Participation and State Acceptance:**

A public availability session was held on December 4, 1997 with the public comment period from November 27, 1997 through December 26, 1997. No comments were received.

The State of Tennessee concurred with the proposed plan on December 18, 1997.

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### List of Acronyms and Abbreviations

ABA	Ammunition Burnout Area
BDL	below detection limit
BW	body weight
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemical of concern
COPC	chemical of potential concern
CR	contact rate
CSF	cancer slope factor
DA	U.S. Department of the Army
DoD	U.S. Department of Defense
13DNB	1,3-dinitrobenzene
24DNT	2,4-dinitrotoluene
2A46DNT	2-amino-4, 6-dinitrotoluene
4A26DNT	4-amino-2, 6-dinitrotoluene
EC	effects concentration
EF	exposure frequency
EPA	U.S. Environmental Protection Agency
EPA	U.S. Environmental Protection Agency
ERM	Environmental Resources Management, Inc.
ESE	Environmental Science & Engineering, Inc.
FDI	Fluor Daniel, Inc.
ft	foot
GAC	granular activated carbon
HI	hazard index
HMX	cyclotetramethylene tetranitramine
HQ	hazard quotient
HRA	health risk assessment
ICF	ICF Kaiser Engineers, Inc.
IRDMIS	Installation Restoration Data Management Information System
LMOS	Lockheed Martin Ordnance Systems, Inc.
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MEV	million electron volt
mg/kg	milligram per kilogram
MLAAP	Milan Army Ammunition Plant
mm	millimeter
MMOS	Martin Marietta Ordnance Systems, Inc.
MOC	Milan Ordnance Center
MOD	Milan Ordnance Depot
NCP	National Contingency Plan
NFA	No Further Action
OBG	Open Burning Ground
PWTF	Pink Water Treatment Facility
RBC	risk-based concentration
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfD	reference dose
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986

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TAL	target analyte list
TDEC	Tennessee Department of Environment and Conservation
135TND	1, 3,5-trinitrobenzene
246TNT	2,4,6-trinitrotoluene
TR	target risk
Ig/g	micrograms per grain
Ig/L	micrograms per liter
USACE	U.S.Army Corps of Engineers
USAEC	U.S.Army Environmental Center
VOC	volatile organic compound
WCOP	Wolf Creek Ordnance Plant



## **MLAAP Record of Decision**

### **Declaration for the Record of Decision**

#### **Site Name and Location**

This Record of Decision (ROD) addresses the following three sites at Milan Army Ammunition Plant (MLAAP), Gibson and Carroll Counties, Tennessee:

- Salvage Yard,
- Former Ammunition Burnout Area, and
- Sanitary Landfill.

#### **Statement of Basis and Purpose**

This decision document presents the selected action for the Salvage Yard, Former Ammunition Burnout Area (ABA), and Sanitary Landfill at MLAAP, located in Gibson and Carroll Counties, TN. No Further Action (NFA) was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) to the extent practicable. Selection of NFA also considered the National Contingency Plan, to the extent practicable, and is based on information in the Administrative Record for MLAAP.

The U.S. Environmental Protection Agency (EPA) and the State of Tennessee concur on the selected remedy.

#### **Description of the Selected Remedy**

This ROD addresses the final response action planned for the Salvage Yard, Former ABA, and Sanitary Landfill, including soil and groundwater. No previous RODs or decision documents have been issued for these sites. A Human Health Evaluation identified no unacceptable risks to human health at these three sites. Furthermore, terrestrial ecological exposure was considered insignificant. Therefore, remedial action is not necessary.

NFA is the selected remedy for soil and groundwater at the Salvage Yard, Former ABA, and Sanitary Landfill. The selected remedy manages the risk to acceptable levels for both human health and the environment and is the final action planned. The selected remedy will ensure risks to human health and the environment are within acceptable limits.

#### **Declaration Statement**

Based on the soil and groundwater investigation results at the Salvage Yard, Former ABA, and Sanitary Landfill, it was determined that no remedial action is necessary to ensure protection of human health and the environment.

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## MLAAP Record of Decision

### 1.0 Site Name, Location, and Description

The Milan Army Ammunition Plant (MLAAP) is located in Gibson and Carroll Counties, in west-central Tennessee, approximately 50 miles east of the Mississippi River (see Fig. 1-1). The City of Milan, with a population of 8,100, borders the installation to the northwest. Other nearby population centers include Humboldt, with a population of 10,200, which lies 12 miles to the southwest; Trenton, with a population of 4,600, which lies 15 miles to the northwest; and Jackson, with a population of 50,000, lies 18 miles south of MLAAP RCF Kaiser Engineers, Inc. (ICF), 1991. MLAAP is served by two rail lines, three U.S. highways, and four state highways. Interstate 40 passes within 13 miles south of the installation.

The three areas at MLAAP addressed in this Record of Decision (ROD) are:

- The Salvage Yard,
- The Former Ammunition Burnout Area (ABA)(sometimes referred to as "Sunny-Slope"), and
- The Sanitary Landfill.

The Salvage Yard at MLAAP is located east of Area J, immediately south of U.S. Highway 104 (Fig. 1-2) in Carroll County, Tennessee. The Salvage Yard occupies about 4.6 acres. All salvageable, non-hazardous scrap, including casings, machinery, and wood generated at MLAAP is stored either in bins or in outdoor piles until sold to a scrap dealer.

The Former ABA at MLAAP is located in Area V of the southwestern portion of the installation (Fig. 1-2) in Gibson County, Tennessee, and occupies approximately 15 acres. The area consists of various concrete aprons and barricaded buildings, an earth-covered storage igloo, and an office building. The area is currently used as a pistol firing range. Surface drainage from the area flows into the West Fork of Wolf Creek [Fluor Daniel, Inc. (FDI), 1996].

The Sanitary Landfill at MLAAP is located north-northwest of Area W (Fig. 1-2) in Carroll County, Tennessee, and occupies about 41 acres. Debris from industrial operations consisting mainly of such items as paper, shipping containers, cardboard boxes, and filter pads are placed in trenches, compacted, and covered with soil (ICF, 1991). The Sanitary Landfill is currently permitted under the State of Tennessee Solid Waste regulations.

Access to all three sites is controlled by MLAAP, via onsite security and/or fences and gates.

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<IMG SRC 98020F3>

## 2.0 Site History and Enforcement Activities

The date the Salvage Yard was first used is not known. In the past, scrap metal was stored outdoors, directly on the ground surface. It was later determined that lead from the scrap piles had leached into the soil (ICF, 1991). Subsequently, lead-containing materials have been stored under a roof.

The Former ABA was built in the spring of 1945 and designated for the disassembly and burning of munitions. Operations consisted of the following sequential unit activities: receiving, base plate removal, defusing, and burring and band removal of individual munitions. Industrial activities in this area are believed to have ceased during the 1950s. No disposal or burial of munitions is thought to have occurred in this area (FDI, 1996). Unit activities were conducted within concrete pad areas and consisted of disassembly and burnout of ordnance items.

The Sanitary Landfill is thought to have been in use since 1960. Historic aerial imagery indicates cleared areas starting in 1960 with various trenches for waste disposal appearing in later years. Rubbish and debris from industrial operations (consisting mainly of paper, shipping containers, cardboard boxes, and filter pads) are placed in trenches, compacted, and covered with soil at the Sanitary Landfill. The trenches are excavated down to a clay material, which may retard leachate migration (FDI, 1996).

MLAAP was constructed between 1940 and 1942 and initially included approximately 28,521 acres. The H.K. Ferguson Engineering Company of Cleveland, Ohio, and the Oman Construction Company of Nashville, Tennessee, formed The Ferguson-Oman Company to design and construct the plant. Various production lines encompassed approximately 550 acres; storage facilities covered approximately 7,380 acres; field services encompassed approximately 9,900 acres; and administrative, shop maintenance, housing, recreation and other functions covered approximately 1,395 acres. The remaining acreage was necessary to comply with regulations regarding safety clearances between explosive manufacturing areas.

Portions of the original acreage have been leased, sold, or deeded to various organizations over the years, including "Line G," which was sold to the United States Rubber Company, acreage that was deeded to the City of Milan and the University of Tennessee, and acreage that was leased or transferred to the Tennessee National Guard. As a result of these and other minor transactions, MLAAP currently (1996) covers about 22,436 acres.

MLAAP has experienced changes to its mission, name, and contract operators throughout the years. A chronology of operational events at MLAAP is summarized as follows:

- |      |   |
|------|---|
| 1942 | MLAAP originally consisted of two facilities: the Wolf Creek Ordnance Plant (WCOP) and the Milan Ordnance Depot (MOD). WCOP was operated by the Proctor and Gamble Defense Corporation, and MOD was operated by the Government.   |
| 1943 | WCOP and MOD were merged into a single facility, the Milan Ordnance Center (MOC). MOC was operated by the Proctor and Gamble Defense Corporation. The mission of the facility included: the production of fuzes, boosters, and completed rounds of small and large caliber munitions; the operation of an ammonium nitrate plant; and the shipment of munitions. Employment peaked at 11,000 from 1943 to 1945. |
| 1945 | MOC was designated as the Milan Arsenal and was placed on standby status under U.S. Department of the Army (DA) operation at the conclusion of World War II. The mission of the facility was changed to the receipt, storage, and processing of ammunition returning from overseas; normal maintenance, surveillance, renovation, and demilitarization; and limited new production.                             |
| 1953 | Milan Arsenal was returned to active status to support the Korean Conflict; Proctor and Gamble Defense Corporation assumed operations. The mission of the facility included increased output of new munitions, inclusion of experimental munitions, and assignment of engineering studies for ordnance munitions loading plants. Employment reached 8,000 from 1953 to 1954.                                    |
| 1954 | Milan Arsenal was designated as a "permanent installation." Production cutbacks   |

resulted in the layaway of various load lines during 1954 and 1955, until all production ceased in 1957, leaving only a small demilitarization program at Line B.

- 1957 Milan Arsenal was placed on inactive status. Proctor and Gamble Defense Corporation terminated their contract with the Government, and Harvey Aluminum Sales, Inc. became operating contractor.
- 1960 The industrial areas at Milan Arsenal were returned to active status. Modernization of these facilities has occurred throughout the 1960s to produce: fuzes, primers, delay plungers, delay elements, and boosters; 40, 60, 81, 90, 105, 106, and 155 millimeter (mm) munitions; mine, grenade, and cluster bomb unit dispensers; demolition kits; shell metal parts; pelleting explosives; and rework and renovation of munitions items.
- 1961 The industrial portion of Milan Arsenal is designated as Milan Ordnance Plant; the field services portion is designated as Milan Depot Activity.
- 1962 Field services activities were discontinued at Milan Depot Activity, and operations were merged with Milan Ordnance Plant. The field services Mission continued under Milan Ordnance Depot.
- 1963 Milan Ordnance Depot was designated as Milan Army Ammunition Plant.
- 1969 Harvey Aluminum Sales, Inc. was acquired by Martin Marietta, Inc. Martin Marietta, Inc. became the operating contractor.
- 1971 Production Lines E, F, and H were placed in layaway. The production of munitions and components on these lines was transferred to other lines on the facility; equipment used to manufacture metal parts was transferred to private industry.
- 1975 Production Line Z was canceled. The line was placed in layaway status in 1976 with production of items transferred to other lines at the plant. Line C production was transferred to Line B in 1977 and then was placed in layaway status.
- 1977 Line H was reactivated to produce LAP M739 fuzes, because it contained the humidity/temperature-controlled led environment necessary to produce fuzes.
- 1978 Modernization of MLAAP was initiated and continued through 1985. Production Lines A, C, and Z were modernized. Automated production of 60- and 81-mm propellant increments was completed under this program in addition to the development of a melting system. Testing/production of these systems was completed in 1983 and then ceased for production layaway in 1984. Limited production of 60- and 81-mm mortar rounds was transferred to Line D.
- An X-ray facility was constructed at Line V to perform all nondestructive testing of munitions at the MLAAP. The X-ray facility [which contains an underground 4-million electron volt (MEV) unit, a 0.420-MEV unit, and a fluoroscope with video tape] is the world's largest facility dedicated to nondestructive testing of munitions.
- 1979 Construction of Pink Water Treatment Facilities (PWTfS) was initiated and completed in 1981. These plants are used to remove explosive contaminants from process water, using filtration and granular activated carbon (GAC) adsorption, prior to water discharge into ditches.
- 1985 Martin Marietta, Inc. organized Martin Marietta Ordnance Systems, Inc. (MMOS), as a subsidiary of Martin Marietta, Inc., to operate MLAAP.
- 1995 MMOS merged with Lockheed to form Lockheed Martin, Inc. and was renamed to Lockheed Martin Ordnance Systems, Inc. (LMOS).
- 1997 General Dynamics became the installation operating contractor.

### 3.0 Highlights of Community Participation

A Remedial Investigation (RI) was conducted by ICF in 1990 to investigate the extent of contamination at the Salvage Yard, Former ABA, and Sanitary Landfill, as well as other areas at MLAAP. The findings were documented in the Remedial Investigation for Milan Army Ammunition Plant (ICF, 1991).

FDI conducted RI work in 1995 and collected supplemental information at the Former ABA and Sanitary Landfill (as well as other sites in the Southern Area); their findings were documented in the Milan Army Ammunition Plant, Remedial Investigation, Southern Study Area (Operable Unit No. 5) (17131, 1996).

The 1991 RI report (ICF, 1991) was released to the public in December 1991. The 1996 RI report (FDI, 1996) was released to the public in April 1996. Both documents were made available to the public in the Administrative Record and at the Information Repositories, maintained at the Army Industrial Operations Office at MLAAP and the Mildred G. Fields Library in Milan, Tennessee. In November 1997, the Proposed Plan for the Salvage Yard, Former ABA, and Sanitary Landfill [Environmental Science & Engineering, Inc. (ESE), 1996] was released to the public.

A public availability meeting announcement for the Proposed Plan was published in the Milan Mirror & Exchange and Jackson Sun. A Public Availability Meeting for the Proposed Plan was held at the Tom C. McCutchen Agricultural Museum on December 4, 1997. At this meeting, representatives from MLAAP, the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (EPA) Region IV, and the Tennessee Department of Environment and Conservation (TDEC) were available to answer questions about the site and the NFA decision under consideration.

A public comment period for the recommended actions at the Salvage Yard, Former ABA, and Sanitary Landfill was held from November 27 through December 26, 1997. Comments received during this period, as well as those received at the public meeting, are addressed in the Responsiveness Summary included in Appendix A.

This document presents the basis for the No Further Action decision at the Salvage Yard, Former ABA, and Sanitary Landfill at MLAAP. This decision was recommended in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Acts (SARA) of 1986, to the extent practicable, the National Contingency Plan (NCP), and the Tennessee Health and Safety Code. This decision for this site was based on the Administrative Record.

#### 4.0 Scope and Role of Response Action

The scope of the response action for the Salvage Yard, Former ABA, and Sanitary Landfill addresses soil and groundwater. This ROD addresses the final response action planned for the Salvage Yard, Former ABA, and Sanitary Landfill. No previous ROD(s) or decision document(s) have been issued for these sites.

Two other RODs have been finalized in OU3 and OU4:

- One for the industrial area soils (these soils located at the manufacturing lines at the installation), and
- One for groundwater (specifically, groundwater in the northern boundary area that is migrating offsite).

Other sites currently under investigation in OU3 and OU4 are:

- The non-industrial area soils (primarily soils and sediments in ditches within OU3), and
- Onsite groundwater.

The onsite groundwater operable unit addresses all groundwater within the installation boundaries, with the exception of those areas addressed by other groundwater operable units, specifically OU1 (O-Line Ponds), the portion of OU3 addressed by the northern boundary groundwater ROD (previously referenced above), and OU4 Region I (X-Line).

No other RODs have been finalized for OU5. OU5 (also referred to as the Southern Study Area) covers the largest land area at MLAAP. Aside from the Former ABA and the Sanitary Landfill, which are discussed in this plan, major areas investigated in OU5 include the:

- Open Burning Ground,
- Former Ammunition Destruction Area,
- Current Ammunition Destruction Area,
- Ammunition Storage Area, and
- Ammunition Test Area.

Those sites within OU3, OU4, and OU5 that are currently under investigation will be discussed with the public in the future.

Several human exposure scenario's were evaluated for the Salvage Yard, Former ABA, and Sanitary Landfill:

- Industrial worker scenario,
- Construction worker scenario, and
- Residential user scenario.

The future residential use scenario is hypothetical and assumes that the Salvage Yard, Former ABA, and Sanitary Landfill can be used for unrestricted land use. An unrestricted land use would permit groundwater wells and residential areas to be constructed anywhere on these three sites. The future residential land use scenario, which was evaluated for comparative purposes, is the most conservative choice for land use and will generate the greatest potential exposure. However, it is unlikely that MLAAP's missions will be eliminated and the plant's land would be used for residential purposes.

Since MLAAP currently fulfills a critical mission that will be necessary as part of future Army operations, and it is Army practice to clean up to the current land use scenario, no clean up decisions were based on the future residential use scenario. If, in the future, MLAAP would be subject to base closure, site-related risk would be re-evaluated in accordance with, U.S. Department of Defense (DoD) base closure policy (10 U.S.C. 2687 and NOTE).

A CERCLA investigation conducted at these sites concluded that the three sites pose no unacceptable risks to either human health or the environment. During the course of this

investigation, MLAAP recommended that these three sites be considered NFA sites (ICF, 1991; FDI, 1996).

A no-action determination is appropriate when:

- The site, or a specific problem or area of the site, poses no current or potential threat to human health or the environment; or
- CERCLA does not provide the authority to take a remedial action; or
- A previous response eliminated the need for further remedial response.

The Salvage Yard and Sanitary Landfill are recommended for NFA because they do not pose a current or potential threat to human health and the environment.

Although the Former ABA is still used as a pistol firing range and the previous mission at this location has ceased, CERCLA has regulatory authority. The Former ABA is recommended for NFA because this site does not pose a current or potential threat to human health or the environment.

EPA and TDEC have reviewed the 1991 RI (ICF, 1991) and 1996 RI (FDI, 1996) and agree that NFA is an appropriate remedial response action for the Salvage Yard, Former ABA, and Sanitary Landfill.

## 5.0 Summary of Site Characteristics

### 5.1 Geology

The 1996 RI report (FDI, 1996) contained a detailed description of the site geology. This description is briefly summarized as follows.

Western Tennessee (including MLAAP) lies on the eastern flank of the Upper Mississippi River Embayment. Structurally, the embayment is a downwarped, downfaulted trough whose axis approximates the current course of the Mississippi River. Sediments, ranging in age from Cretaceous to Recent, have been deposited in this trough. These sediments consist of gravel, sand, clay, lignite, chalk, and limestone units of varying thicknesses.

MLAAP is situated on the Memphis Sand (or "500-foot" sand) of the Claiborne Group of Tertiary age in the Gulf Coastal Plain of western Tennessee. The Memphis Sand crops out in a broad belt across western Tennessee, but is covered in most places by fluvial deposits of Tertiary and Quaternary age and loess and alluvium of Quaternary age. The eastern boundary of the Memphis Sand and the contact between the Wilcox and Claiborne Groups in the subsurface have been mapped by various researchers. The western boundary of the outcrop belt is not well established because the contact between the Memphis Sand and the overlying Cook Mountain Formation is covered by fluvial deposits, loess, or alluvium.

The Memphis Sand consists of a thick body of sand that includes subordinate lenses or beds of clay and silt at various horizons. The clay and silt locally are carbonaceous and lignitic; thin lenses of lignite also occur locally. Thick beds of clay and silt in the upper part of the Memphis Sand may, in some places, be confused with the overlying Cook Mountain Formation.

Sand in the Memphis Sand ranges from very fine to very coarse, but is commonly fine, fine to medium, or medium to coarse. The Memphis Sand ranges to 900 feet (ft) thick. The formation is thinnest along the eastern limits of the outcrop belt in Hardeman, Madison, Carroll, and Henry Counties. In western Tennessee, the base of the Memphis Sand dips westward at rates of 20 to 50 ft per mile.

The Claiborne Group is underlain by the Wilcox Group, which consists of the Flour Island Formation, the Fort Pillow Sand (or "1,400-foot" sand), and the Old Breastwork's Formation (listed in increasing depth). The Flour Island Formation consists primarily of clay, silt, sand, and lignite and is not an aquifer. Where present, it serves as the lower confining unit for the Memphis Sand and the upper confining unit of the Fort Pillow Sand. The Flour Island Formation is approximately 50 ft thick in the vicinity of MLAAP.

A geologic cross section through MLAAP identifies the stratigraphic units underneath this area. Underlying the Wilcox is the Porters Creek Clay, which acts as a confining unit between the Fort Pillow Sand of the Wilcox Group and the McNairy Sand of Cretaceous age. The exact depth to rock under MLAAP is unknown. A test well drilled to 1,289 ft about 20 miles south-southwest of MLAAP near Jackson, Tennessee, was stopped in a sandy clay marl. It was estimated that rock (possibly limestone) would be encountered between 500 to 800 ft below the drilled depth of the test well (FDI, 1996).

#### 5.1.1 Soil

The surface soils at MLAAP consist chiefly of a reddish-brown to yellow, mottled, silty clay that grades into a clay unit with depth. The soil types include the Memphis, Loring, Grenada, Calloway, Henry, Falaya, and Waverly soil associations. Based on topography, the Memphis and Loring series occur on higher elevations and are well-drained soils. The Henry soil series is somewhat poorly drained and is usually associated with flat terrain, while the Falaya and Waverly soils associations occur in the low areas and are poorly drained.

Drill logs from borings installed at the site indicate that the upper 12 to 15 ft of soil consists of reddish-brown to tan silty lean clay with some layers of sandy and fat clay. Below these depths, sands with varying amounts of silts and clays, have been encountered. Occasional gravel, up to 3/8-inch diameter, has been encountered during boring operations. A more sandy



alluvium of lesser thickness (5 to 10 ft) has been observed in several areas across the site. Natural and artificial drainage systems have incised into the alluvium in several locations.

### **5.1.2 Groundwater**

Groundwater in the MLAAP area generally flows northwest, in the direction of regional dip of these sands, and also trends northerly because of the topographic influence. On a general scale, there are no abrupt hydrologic boundaries in the aquifer. The formation is recognized as sand with clay lenses and clay rich zones, which may locally alter vertical groundwater flow, and stratification of the sediments tends to make vertical conductivities lower than horizontal conductivities.

## **5.2 Characteristics of Contamination**

This section summarizes the findings of characterization studies conducted for soil and groundwater at the Salvage Yard, Former ABA, and Sanitary Landfill.

### **5.2.1 Salvage Yard**

#### **5.2.1.1 Groundwater**

Monitor well MI035, located downgradient from the Salvage Yard, has been sampled five times between 1983 and 1997. The location of MI035 with respect to the Salvage Yard is depicted in Fig. 5-1. Target analytes in sampling efforts have included metals, volatile organic compounds (VOCs), and explosives, although not all analytes were targeted in each of the five sampling episodes.

No VOCs or explosives were detected in any of the samples collected from MI035 between 1983 and 1997. Thirteen metals were detected. Table 5-1 presents the analytical results for groundwater at the Salvage Yard as well as relevant background information, regulatory criteria, and sampling dates. With the exception of cadmium and mercury in 1983, all metals were less than maximum contaminant levels (MCLs) and/or two-times the site-specific background concentration [Environmental Resources Management, Inc. (ERM), 1995]. Based on EPA Guidance (EPA, 1995), site constituents present at concentrations less than two-times the site-specific background concentration do not need further evaluation (see Sec. 6.0).

The elevated levels of cadmium and mercury at MI035 were reported for samples collected in 1983. Since that time, MI035 was sampled four more times. Cadmium was targeted for all four sampling efforts, and mercury was targeted twice and most recently. Cadmium was detected at a concentration of 3.68 micrograms per liter (µg/L) in September 1988; it was not detected in sampling events conducted in January 1989, October 1990, and April 1997. Mercury was not detected in either of the two sampling events (October 1990 and April 1997) where it was a targeted analyte. Based on this information, the 1983 data is not considered representative. Results of these analyses show cadmium and mercury to be present at concentrations less than MCLs and less than two-times the site-specific background concentrations established for the site.

#### **5.2.1.2 Soil**

ICF collected subsurface soil samples at the Salvage Yard and reported findings in the 1991 RI Report (ICF, 1991). Two soil borings were installed to address potential contamination (Fig. 5-2): Boring SYD-1 was placed downgradient from the lead bin; and Boring SYD-2 was placed downgradient from the metal scrap pile. Because a railroad track is located upgradient of the lead bin, an upgradient boring was not installed. Samples were collected at a depth of 5 to 7 feet.

Twelve metals and four organic chemicals were detected in soil samples collected from the Salvage Yard. Table 5-2 summarizes these data and provides relevant background soil information. Aluminum, arsenic, barium, calcium, lead, manganese, magnesium, silver, and vanadium were detected at concentrations greater than two-times the site-specific background concentrations (FDI, 1996). All other metals were reported at concentrations less than two-times the site-specific background concentrations or were not detected. Based on EPA

**Table 5-1. Range and Maximum Constituent Concentrations Reported  
for Groundwater Data at the Salvage Yard**

Chemical	MI035 (63ft)	MCL6	2x Background	
		(I g/L)	Background1	(I g/L)
		Exceeded? (Yes/No)	(I g/L)	Exceeded? (Yes/No)
Inorganic Compounds:				
Aluminum	ND-137	200 5/No	27,750	55,500/No
Barium	43-45.1	2,000/No	81.5	163/No
Calcium	6,560-6,740	--/--	19,100	38,200/No
Cadmium	ND-41 3(3.68)	5/No 8	ND	ND/Yes
Chromium	ND-13	100/No	21.3	42.6/No
Copper	ND-12.9	2,000/No	35.7	71.4/No
Iron	ND-312	300 5/Yes	18,450	36,900/No
Lead	ND-1.41	157/No	ND	ND/Yes
Mercury	ND-3.3 4	2/No 9	ND	ND/Yes
Potassium	1,980-2,470	--/--	2,240	4,480/No
Magnesium	1,540-2,340	--/--	6,855	13,710/No
Manganese	5.91-7.55	50 5/No	231.5	463/No
Sodium	3,660-3,760	--/--	33,050	66,100/No

Dates Sampled 2: 3/83, 9/88, 1/89, 10/90, 4/97

Note: -- = not determined.

ND = not detected.

1 Based on data from MI229, as presented in ERM, 1995.

2 Not all metals were targeted in all events.

3 Value reported for 3/83. Subsequent samples collected in 9/88, 1/89, 10/90, and 4/97 show cadmium less than the MCL (maximum of 3.68 I g/L); 3/93 data are not considered representative.

4 Value reported for 3/83. Subsequent samples, collected in 10/90 and 4/97, show mercury less than the MCL and non-detect, 3/83 data are not considered representative.

5 40 CFR Part 143, Secondary MCL.

6 40 CFR Part 141, MCL.

7 40 CFR Part 141, action level in no more than 10 percent of the tap samples.

8 When 3/83 data is disregarded, see Note 3.

9 When 3/83 data is disregarded, see Note 4.

Source: QST.

**Table 5-2. Range and Maximum Constituent Concentrations Reported for  
Subsurface Soils at the Salvage Yard**

<b>Chemical</b>	<b>SYD-1 5-7ft 1</b>	<b>SYD-2 5-7ft</b>	<b>Background (mg/kg)</b>	<b>2x Background (mg/kg)</b>	<b>2x Background Exceeded?</b>
<b>Inorganic Compounds:</b>					
Aluminum	10350	11000	5390	10780	Yes
Antimony	ND	ND	ND	ND	No
Arsenic	4.64	3.51	1.73	3.46	Yes
Barium	132	139	22.1	44.2	Yes
Beryllium	ND	ND	ND	ND	No
Calcium	854	659	234	468	Yes
Cadmium	ND	ND	ND	ND	No
Cobalt	ND	ND	1.36	2.72	No
Chromium	ND	ND	9.27	18.54	No
Copper	ND	ND	4.33	8.66	No
Iron	11000	9900	5730	11460	No
Lead	18	7.94	2.42	4.84	Yes
Manganese	984	761	50.3	100.6	Yes
Magnesium	1920	1840	370	740	Yes
Mercury	ND	ND	ND	ND	No
Nickel	ND	ND	3.86	7.72	No
Potassium	423	492	251	502	No
Selenium	ND	ND	0.26	0.52	No
Silver	0.313 (2)	ND	ND	ND	Yes
Sodium	414	392	364	728	No
Thallium	ND	ND	ND	ND	No
Vanadium	34.5	32.8	16.1	32.21	Yes
Zinc	ND	ND	9.67	19.34	No
<b>Organic Compounds:</b>					
Acetone	0.046 (2)	0.061	--	--	
2-Propanol	NR	0.24	--	--	
Trichloroethene	0.064	<0.0059	--	--	
Toluene	0.12	<0.0078	--	--	

Notes: -- = not determined.  
ND = not detected.  
NR = not reported.

1 Average concentration of original and duplicate samples.

2 Average concentration of original and duplicate sample, where one result was below detection limits.

Source: QST.

Guidance (EPA, 1995), site constituents present at concentrations less than two-times the site-specific background concentration do not need further evaluation (see Sec. 6.0). Sec. 6.0 discusses the significance of the metals detected in excess of the site specific average background concentration and organic constituents (acetone, 2-propanol, trichlorofluoromethane, and toluene) reported in Table 5-2.

The 1991 RI report concluded that contaminant loading from the Salvage Yard into groundwater was not occurring (ICF, 1991).

In 1997, QST collected two surficial soil samples (0 to 1 ft) from approximately the sample locations as the borings collected for the RI effort conducted in 1990; metals and explosives were targeted for these two samples. This data is summarized in Table 5-3. RDX was detected in one sample (SYD-2) at a concentration of 0.172 milligrams per kilogram (mg/kg). Except for beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, silver, sodium, thallium, and zinc, all other metals were reported at levels less than two-times the site-specific background concentration or were not detected, and thus do not need further evaluation (see Sec. 6.0). Sec. 6.0 discusses the significance of the metals detected in excess of the site specific average background concentration and RDX reported in Table 5-3.

### **5.2.2 Former ABA**

#### **5.2.2.1 Groundwater**

Six monitor wells were installed in the Former ABA (Fig. 5-3). Table 5-4 summarizes analytical data collected at each well, as well as relevant background information, regulatory criteria, and sampling dates. Each monitor well at the Former ABA was sampled at least once, but was not always analyzed for all of the constituents listed in Table 5-4.

Twenty metals and six organic compounds were detected in groundwater between 1990 and 1995. Five explosive-related compounds (135TNB, 13DNB, HMX, nitrobenzene, and RDX) were detected at low concentrations. Bis-2-ethylhexyl phthalate was also detected once at a concentration of 5.7 **Ig/L**. Sec. 6.0 discusses the environmental significance of the organics reported in the Former ABA.

Of the 20 metals detected at wells in the Fortner ABA, 14 have either primary or secondary MCLs, and all have established site-specific background concentrations. Seven primary or secondary MCLs were exceeded over the course of all sampling events; 16 occurrences of a metal exceeding two-times the average site-specific average background concentrations were documented. Seven metals exceeded both MCLs and levels two-times the average site-specific average background concentrations.

The maximum concentration of cadmium as listed in Table 5-3 was 23.2 **Ig/L** for MI073. This sample was collected in November 1990. Subsequent samples collected in May 1994 [below detection limit (BDL)], October 1994 (BDL), and February 1995 (2.17 **Ig/L**) detected cadmium concentrations below MCLs. Given the subsequent data for cadmium at MI073, it would not be appropriate to consider the high concentration reported in 1990 as representative.

With respect to metals, MI233 generally contained the highest concentrations, as listed in Table 5-3. This well was only sampled once, therefore, no subsequent data have been collected to confirm the elevated metals reported at MI233. Because MI227 (the shallow well clustered with MI233) does not show similar or higher levels of contamination, this indicates that the source of the elevated metals at MI233 is not the Former ABA. MI233 is screened in a fine sand zone of the aquifer, and thus elevated metals may be due to solids related to soil material in samples and are not representative of groundwater.

Sec. 6.5.2 presents more information on the environmental significance of data reported in Table 5-3.

**Table 5-3. Range and Maximum Constituent Concentrations Reported for  
Surface Soils at the Salvage Yard**

<b>Chemical</b>	<b>SYD-1 (0-1 ft) (mg/kg)</b>	<b>SYD-2 1 (0-1 ft) (mg/kg)</b>	<b>Background (mg/kg)</b>	<b>2x Background (mg/kg)</b>	<b>2x Background Exceeded?</b>
<b>Inorganic Compounds:</b>					
Aluminum	3750	4490	12478.33	24956.66	No
Antimony	ND	ND	2.21	4.42	No
Arsenic	3.27	5.97	5.03	10.06	No
Barium	65	186	99.37	198.74	No
Beryllium	ND	1.62	0.49	0.98	Yes
Calcium	2370	5500	4317	8634	No
Cadmium	20.9	29.5	1.23	2.46	Yes
Cobalt	4.25	6.04	6.93	13.86	No
Chromium	8.56	75.2	16.17	32.34	Yes
Copper	13000	462	21.36	42-72	Yes
Iron	8110	45200	14833.33	29666.66	Yes
Lead	195	639	15	30	Yes
Manganese	462	494	638	1276	No
Magnesium	419	139	1459.5	2919	No
Mercury	ND	0.343	0.11	0.22	Yes
Nickel	7.16	34.8	13.06	26.12	Yes
Potassium	368	334	695.7	1391.4	No
Selenium	ND	ND	0.29	0.58	No
Silver	1.2	2.35	ND	ND	Yes
Sodium	230	459	225.5	451	Yes
Thallium	ND	39.1	ND	ND	Yes
Vanadium	12.6	16.4	27.38	54.76	No
Zinc	340	2495	63.03	126.06	Yes
<b>Organic Compounds:</b>					
RDX	<0.163	0.172	ND	ND	No

Note: ND = not detected.

1 Average concentration of original and duplicate samples.

Source: QST.

<IMG SRC 982020F6>

Table 5-4. Groundwater Results for the Former ABA

Chemical	MI073	MI226	MI227	MI228	MI232	MI233	MCL 6	Background 7	2x
	(94 ft) 4	(35 R) 4	(32 ft) 4	(130 ft) 4	(80 ft) 4	(90 ft) 4	(I g/L)/		(I g/L)/
	(I g/L)	(I g/L)	(I g/L)	(I g/L)	(I g/L)	(I g/L)	Exceeded? Yes/No	(I g/L)	Exceeded? (Yes/No)
Inorganic Compounds:									
Aluminum	54.4-1,350	868-1,140	550-1,070	1,560-5,570	1,470-9,500	67,600	200/Yes 1	27,750	55,500/Yes
Antimony	ND	ND	ND	ND	ND	ND	6/No	ND	No/No
Arsenic	1.25	ND	ND	ND-3.09	1.1	16.6	50/No	6.08	12.15/Yes
Barium	12.7-22.3	108-120	120-123	49.3-75.9	34.5-91.8	362	2,000/No	81.5	163/Yes
Beryllium	0.51	0.63	0.65	0.58	0.61	7.63	4/Yes	ND	ND/Yes
Calcium	1,600-2,990	3,080-3,610	3,160-3,990	1,890-4,800	3,740-6,800	28,500	--/--	19,100	38,200/No
Cadmium	2.17-23.2 3	3.14	2.54	2.54	1.69	ND	5/No 3	ND	ND/Yes
Cobalt	3.36	4.67	5.11	4.28	4.75	ND	--/--	ND	ND/Yes
Chromium	3.16	ND-15.4	ND-36.1	8.88-9.31	8.33-26.1	116	100/Yes	21.3	42.6/Yes
Copper	2.16-14.3	4.33	4.72	6.1-13.1	3.94-22.8	73.5	1,300/No 2	35.7	71.4/Yes
Iron	49.5-974	876-1,530	471-1,300	1,480-1,590	1,210-12,700	39,600	300/Yes 1	18,450	36,900/Yes
Mercury	ND-1.12	0.232	ND	ND	ND	2.23	2/Yes	ND	ND/Yes
Potassium	ND-1,510	1,220-1,620	681-1,330	1,130-5,660	1,280-2,410	5,880	--/--	2,240	4,480/Yes
Magnesium	497-555	1,510-1,700	1,700-1,800	939-1,360	1,490-2,370	10,900	--/--	6,855	13,710/No
Manganese	10.7-39.7	34.8-40.9	63.8-87.3	58.2-154	27.7-219	1,200	50/Yes 1	231.5	463/Yes
Sodium	6,050-9,180	4,650-4,900	4,880-5,950	5,040-13,900	5,040-5,830	58,700	--/--	33,050	66,100/No
Nickel	4.86	13.5	33.2	9.68	8.48	ND	100/No	ND	ND/Yes
Lead	1.15-5.42	1.63-2.25	ND-4.23	2.8-3.58	2.5-16.6	180	15/Yes 2	12.85	25.7/Yes
Selenium	ND	0.95	1.9	ND	ND	ND	50/No	ND	ND/Yes
Silver	ND	ND	ND	ND	ND	ND	50/No	ND	No/No
Thallium	ND	ND	ND	ND	ND	ND	2	ND	No/No
Vanadium	ND	5.6	5.83	7.53-20.8	8.06-55.8	275	--/--	50.1	100.2/Yes

Table 5-4. Groundwater Results for the Former ABA

Chemical	MI073 (94 ft) 4 (I g/L)	MI226 (35 R) 4 (I g/L)	MI227 (32 ft) 4 (I g/L)	MI228 (130 ft) 4 (I g/L)	MI232 (80 ft) 4 (I g/L)	MI233 (90 ft) 4 (I g/L)	MCL 6 (I g/L)/ Exceeded? Yes/No	Background 7 (I g/L)	2x Background (I g/L)/ Exceeded? (Yes/No)
Zinc	10.2-44.7	13.8	ND-22	17.8-67.2	14.8-45	138	5,000/No 1	81.75	163.5/No
Organic Compounds:									
135TNB	ND-0.107	0.223	0.188-0.285	0.137-0.153	ND	0.475	--/--	--	--/--
13DNB	ND	ND	0.634-0.893	ND	ND	ND	--/--	--	--/--
bis-2-ethylhexyl phthalate	5.7	NA	NA	NA	ND	NA	6/No	--	--/--
HMX	ND	ND-1.69	ND	ND	ND	ND	--/--	--	--/--
Nitrobenzene	ND	0.596	ND	ND	ND	0.489	--/--	--	--/--
RDX	ND	ND	ND	0.395-0.422	ND	ND	--/--	--	--/--
Sample Dates 5	11/90	5/94	5/94	5/94	5/94	5/94			
	5/94	2/95	2/95	2/95	2/95				
	10/94								
	2/95								

Note: -- = not determined.  
ND = not detected.

- 1Secondary MCL, 40 CFR Part 143.
- 240 CFR Part 141, action levels in no more than 10 percent of the tap samples.
- 3High of 23.2 ppb cadmium reported in Nov/90. Subsequent samples collected in May/94 (ND), Oct/94 (ND), and Feb/95 (2.17 I g/L)report cadmium less than MCL; therefore, site data do not support the use of the 23.2 ppb cadmium concentration for screening.
- 4FDI, 1996.
- 5Not all analytes were targeted on referenced dates.
- 640 CFR Part 141, MCLs.
- 7Background from MI229, as presented in ERM, 1995.

Source: QST.

#### 5.2.2.2 Soil

ICF collected fifteen soil samples and one sediment sample at the Former ABA and reported findings in the 1991 RI report (ICF, 1991). Five soil borings (CBG-1 to CBG-5) were completed to investigate potential soil contamination resulting from past burn activities (Fig. 5-4). All soil boring sites were drilled to 12 ft; three samples per boring were collected. One sediment sample (CREK-1) was collected from the west fork of Wolf Creek where the ditch from the burnout pad drains into the creek. Soil and sediment samples were analyzed for inorganic and organic chemicals.

A total of five surface soil samples (0-2 ft) and one sediment sample (0-1 ft) were collected at shallow depths. Fifteen metals and five organic compounds were detected in surface soil and sediment samples collected from the Former ABA. This information is presented in Table 5-5, along with relevant site-specific background information. Four of the samples were only analyzed for cadmium, chromium, lead, and mercury. The other two samples were analyzed for the TAL metals. Sample CREK-1 generally contained the highest levels of constituents at the Former ABA. With the exception of arsenic, barium, calcium, cobalt, chromium, iron, lead, manganese, magnesium, silver, and vanadium, all other metals were reported at concentrations less than two-times the average site-specific background concentration or were not detected. Based on EPA Guidance (EPA, 1995), site constituents present at concentrations less than two-times the site-specific background concentration do not need further evaluation. Organic compounds detected in soil samples from the Former ABA were present at low concentrations.

A total of 10 deep soil samples (five at 5 to 7 ft, and five at 10 to 12 ft) were collected at the Former ABA. Six of the ten samples were only analyzed for cadmium, chromium, lead, and mercury. The remaining samples were analyzed for TAL metals. Fourteen metals and five organic compounds were detected in soil samples collected from the Former ABA; these data are summarized in Table 5-6, along with relevant site-specific background information. With the exception of aluminum, arsenic, barium, calcium, chromium, iron, lead, manganese, magnesium, potassium, silver, and zinc, all metals were present at concentrations less than two-times the site-specific background concentrations established for the Southern Study Area (FDI, 1996) or were not detected. Based on EPA Guidance (EPA, 1995), site constituents present at concentrations less than two-times the site-specific background concentration do not need further evaluation. Organic compounds detected in soil samples from the Former ABA were present at low concentrations.

Sec. 6.0 discusses the significance of the other metals detected in excess of site specific background concentrations and the organic constituents reported in Table 5-6.

The 1991 RI report (ICF, 1991) concluded that there is no evidence that the Former ABA is contributing to groundwater contamination.

#### 5.2.3 Sanitary Landfill

##### 5.2.3.1 Groundwater

Data from 11 monitor wells, located downgradient and side gradient to the Sanitary Landfill, were evaluated with respect to groundwater quality (Fig. 5-5). Twenty-four organic compounds and 21 metals were detected in these monitor wells during 13 sampling episodes conducted between 1982 and 1994. Table 5-7 summarizes these data, as well as site-specific average background data for groundwater, regulatory criteria, and sample dates.

Organic compounds were generally detected infrequently and at low concentrations. Although explosive-related compounds (135TNB, 246TNT, 24DNT, 2A46DNT, 4A26DNT, nitrobenzene, tetryl, HMX, and RDX) were detected, the source of these constituents is not believed to be the Sanitary Landfill.



Table 5-5. Surface Soils Data Reported for the Former ABA

Chemical	CBG-1 (0-2 ft) (mg/kg)	CBG-2 (0-2 ft) (mg/kg)	CBG-3 (0-2 ft) (mg/kg)	CBG-4 (0-2 ft) (mg/kg)	CBG-5 (0-2 ft) (mg/kg)	CREK-1 (0-1 ft) (mg/kg)	Background 1 (mg/kg)	2x Background (mg/kg) / Exceeded? (Yes/No)
<b>Inorganic Compounds:</b>								
Aluminum	6500	--	--	--	--	4600	12478.33	24956.66/No
Antimony	<3.8	--	--	--	--	<3.8	2.21	4.42/No
Arsenic	3.58	--	--	--	--	15	5.03	10.06/Yes
Barium	169	--	--	--	--	1200	99.37	198.74/Yes
Beryllium	<1.86	--	--	--	--	<1.86	0.49	0.98/No
Calcium	15000	--	--	--	--	637	4317	8634/Yes
Cadmium	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	1.23	2.46/No
Cobalt	<15	--	--	--	--	54.2	6.93	13.86/Yes
Chromium	<12.7	<12.7	<12.7	<12.7	<12.7	42	16.17	32.34/Yes
Copper	<58.6	--	--	--	--	<58.6	21.36	42.72/No
Iron	7800	--	--	--	--	32000	14833.33	29666.66/Yes
Lead	15.4	30.2	80.2	58	13.3	17	15	30/Yes
Manganese	1230	--	--	--	--	6690	638	1276/Yes
Magnesium	1280	--	--	--	--	519	1459.5	2919/No
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.22/No
Nickel	<12.6	--	--	--	--	<12.6	13.06	26.12/No
Potassium	334	--	--	--	--	178	695.7	1391.4/No
Selenium	<0.25	--	--	--	--	<0.25	0.29	0.58/No
Silver	0.0758	--	--	--	--	<0.025	ND	0/Yes
Sodium	348	--	--	--	--	346	225.5	451/No
Thallium	<31.3	--	--	--	--	<31.3	ND	0/No
Vanadium	80	--	--	--	--	59.1	27.38	54.76/Yes
Zinc	58.9	--	--	--	--	<30.2	63.03	126.06/No
<b>Organic Compounds:</b>								
Acetone	0.025	--	--	--	--	<0.017	--	--/--
1,2-Epoxy- cyclohexene	0.34	--	--	--	--	0.22	--	--/--
2-Cyclohexen- 1-ol	0.22	--	--	--	--	0.22	--	--/--
2-Cyclohexen- 1-one	0.11	--	--	--	--	0.11	--	--/--
Trichloro- flouromethane	<0.0059	--	--	--	--	<0.0059	--	--/--
Palmatic Acid	0.22	--	--	--	--	NR	--	--/--

Note: -- = not determined.

ND = - not detected.

NR = - not reported.

1 FDI, 1996.

Source: QST.

Table 5-6. Surface Soils Data Reported for the Former ABA

	CBG-1		CBG-1		CBG-2		CBG-2		CBG-3		CBG-3		CBG-4		CBG-4		CBG-5		CBG-5		
	5-7 ft (mg/kg)	10-12 ft (mg/kg)	5-7 ft (mg/kg)	10-12 ft (mg/kg)	5-7 ft (mg/kg)	10-12 ft (mg/kg)	5-7 ft (mg/kg)	10-12 ft (mg/kg)	5-7 ft (mg/kg)	10-12 ft (mg/kg)	5-7 ft (mg/kg)	10-12 ft (mg/kg)	5-7 ft (mg/kg)	10-12 ft (mg/kg)	5-7 ft (mg/kg)	10-12 ft (mg/kg)	Background (mg/kg)		2x Background (mg/kg)/ Exceeded? (Yes/No)		
Inorganic Compounds:																					
Aluminum	--	--	--	12000	--	--	7800	6700	--	--	--	--	7200	5390			10780/Yes				
Antimony	--	--	--	<3.8	--	--	<3.8	<3.8	--	--	--	--	<3.8	ND			0/No				
Arsenic	--	--	--	9.91	--	--	4.05 (1)	2.38	--	--	--	--	7.98	1.73			3.46/Yes				
Barium	--	--	--	220	--	--	127 (1)	100	--	--	--	--	142	22.1			44.2/Yes				
Beryllium	--	--	--	<1.86	--	--	<1.86	<1.86	--	--	--	--	<1.86	ND			0/No				
Calcium	--	--	--	980	--	--	700 (1)	412	--	--	--	--	740	234			468/Yes				
Cadmium	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05	<3.05			ND	0/No			
Cobalt	--	--	--	<15	--	--	<15	<15	--	--	--	--	<15	1.36			2.72/No				
Chromium	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	<12.7	26.6			9.27	18.54/Yes			
Copper	--	--	--	<58.6	--	--	<58.6	<58.6	--	--	--	--	<58.6	4.33			8.66/No				
Iron	--	--	--	22000	--	--	12000 (1)	9800	--	--	--	--	15000	5730			11460/Yes				
Lead	6.77	14	14	15	5.97	7.95 (1)	7.6	8.42 (1)	5.65	9.39	2.42	4.84/Yes									
Manganese	--	--	--	805	--	--	544 (1)	461	--	--	--	--	751	50.3			100.6/Yes				
Magnesium	--	--	--	3530	--	--	1018 (1)	1180	--	--	--	--	1130	370			740/Yes				
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	ND			0/No				
Nickel	--	--	--	<12.6	--	--	<12.6	<12.6	--	--	--	--	<12.6	3.86			7.72/No				
Potassium	--	--	--	752	--	--	383 (1)	360	--	--	--	--	489	251			502/Yes				
Selenium	--	--	--	<0.25	--	--	<0.25	<0.25	--	--	--	--	<0.25	0.26			0.52/No				
Silver	--	--	--	<0.025	--	--	<0.025	<0.025	--	--	--	--	0.0396	ND			0/Yes				
Sodium	--	--	--	578	--	--	292 (2)	288	--	--	--	--	359	364			728/No				
Thallium	--	--	--	<31.3	--	--	<31.3	<31.3	--	--	--	--	<31.3	ND			0/No				
Vanadium	--	--	--	29	--	--	17.5 (1)	14.9	--	--	--	--	31	16.1			32.2/No				
Zinc	--	--	--	111	--	--	<30.2	<30.2	--	--	--	--	<30.2	9.67			19.34/Yes				
Organic Compounds:																					
Acetone	--	--	--	0.052	--	--	0.088 (1)	0.059	--	--	--	--	0.03	--			--/--				
1,2-Epoxy cyclohexene	--	--	--	0.38	--	--	NR	NR	--	--	--	--	NR	--			--/--				
2-Cyclohexen-1-ol	--	--	--	0.25	--	--	NR	NR	--	--	--	--	NR	--			--/--				
2-Cyclohexen-1-one	--	--	--	0.13	--	--	NR	NR	--	--	--	--	NR	--			--/--				
Trichloroflouromethane	--	--	--	0.019	--	--	0.013 (1)	0.017	--	--	--	--	0.017	--			--/--				
2-Propanol	--	--	--	0.38	--	--	0.54 (1)	0.069	--	--	--	--	0.023	--			--/--				

Note: -- = not determined.  
NR = not reported.

(1) Average of two.

(2) Average of two, one below detection limit.

Source: QST.

Table 5.7. Groundwater Results for Monitor Wells Located Near the Sanitary Landfill  
(Page 1 of 3)

Chemical (Depth) 3	MI279 (151 ft) (l g/L)	MI280 (295 ft) (l g/L)	003 (222 ft) (l g/L)	MI264 (125 ft) (l g/L)	MI265 (295 ft) (l g/L)	004 (164 ft) (l g/L)	MI266 (115 ft) (l g/L)	MI267 (295 ft) (l g/L)	MI062 (100 ft) (l g/L)	MI063 (160 ft) (l g/L)	MI064 (247 ft) (l g/L)	MCL (l g/L) / Exceeded? (Yes/No)	Background (l g/L)	2x Background (l g/L) / Exceeded? (Yes/No)
Inorganic Compounds:														
Silver	ND	2.52-3.37	ND	ND	ND	ND	ND	ND	ND	ND	ND	50/No	ND	ND/Yes
Aluminum	83.2	5820	34.3	11600	3080	359	24000	4090	1520	1160	336	200 1/Yes	27,750	55,500/No
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6-No	ND	ND/No
Arsenic	ND	1.4	ND	4.4	1.4	ND	4.8	1.75	1.3	ND	ND	50/No	6.08	12.15/No
Barium	17.9	21.4-23	29.8	5.21-56.9	13.9	15.8	51.5	23.2	15.3-20	8.61-23.4	11.3-15.8	2,000/No	81.5	163/No
Beryllium	0.54	0.94-0.97	ND	0.31	0.47	0.51	1.54	ND	ND	ND	ND	4/No	ND	ND/Yes
Calcium	3,290	2,250- 2,270	8,760	1,770- 1,970	3,090	1,660	4,610	3,130	1,770- 2,520	2,310- 10,500	2,500- 31,000	--/--	19,100	38,200/No
Cadmium	2.85	1.91-2.78	ND-194	ND	ND	ND-9	3.81	ND	ND-4.08	ND-5.33	ND-70.9	5/Yes	ND	ND/Yes
Cobalt	4.31	5.16-5.23	ND	5.76	ND	ND	ND	ND	ND	ND	ND	--/--	ND	ND/Yes
Chromium	4.07	9.92-10.4	ND	15.7-19.9	ND	ND	20	ND	ND-11.9	ND-9.16	ND	100/No	21.3	42.6/No
Copper	3.24	8.34-9.67	9.1	31.3-35.3	5.85	2.85	13.7	9.34	ND	ND-13.7	3.44-35.3	1,300 2/No	35.7	71.4/No
Iron	137	2,740- 3,000	ND-64.1	10,800- 12,100	2,970	ND-319	11,000	4,120	386-2,170	ND-1,490	87.1-182	300 1/Yes	18,450	36,900/No
Mercury	ND	ND	ND-2.6	0.59-0.79	ND	ND-3.9	ND	0.22	ND	ND	ND	2/Yes	ND	ND/Yes
Potassium	1,150	1,080- 1,310	1,070	548-771	2,010	ND	1,680	447	426-1,100	899-9,410	414-85,000	--/--	2,240	4,480/Yes
Magnesium	1,260	1,170- 1,260	4500	1,350- 1,490	1,480	610	3,540	1,380	809-862	ND-898	ND-650	--/--	6,855	13,710/No
Manganese	16.7	72.3-73.5	ND-2.67	95.6-107	60.3	ND-8.07	137	83.3	4.29-12.1	7.45-50.6	4.53-33.5	50 1/Yes	231.5	463/No
Sodium	11,100	3,600- 3,630	19,900- 24,500	6,540- 7,260	8,240	3,440- 4,040	40,500	4,860	3,500- 3,590	4,350- 4,850	3,080- 17,400	--/--	33,050	66,100/No
Nickel	8.47	7.66-9.32	ND	8.5-8.61	6.99	5.9	9.74	ND	ND	ND	ND	100/No	ND	ND/Yes
Lead	1.2	5.75-6.25	ND-18.6	8.3-8.6	8.8	ND-9.65	12.8	10	ND-9.33	ND-6.51	1.63-7.05	15 2/Yes	12.85	23.9/No

Table 5.7. Groundwater Results for Monitor Wells Located Near the Sanitary Landfill  
(Page 2 of 3)

Chemical (Depth) 3	MI279	MI280	003	MI264	MI265	004	MI266	MI267	MI062	MI063	MI064	MCL (l g/L) / Exceeded? (Yes/No)	Background (l g/L)	2x Background (l g/L) / Exceeded? (Yes/No)
	(151 ft) (l g/L)	(295 ft) (l g/L)	(222 ft) (l g/L)	(125 ft) (l g/L)	(295 ft) (l g/L)	(164 ft) (l g/L)	(115 ft) (l g/L)	(295 ft) (l g/L)	(100 ft) (l g/L)	(160 ft) (l g/L)	(247 ft) (l g/L)			
Selenium	0.8	0.55-0.7	1.1	ND	ND	ND	1.2	ND	ND	ND	ND	50/No	ND	ND/Yes
Thallium	ND	ND	ND	ND	ND	ND	NA	ND	ND	ND	ND	--/--	ND	ND/No
Vanadium	2.46	12.7	13.2	30.5-35.3	ND	ND	27	6.42	ND	ND	ND	--/--	50.1	100.2/No
Zinc	15.4	21.9-25.2	36.2	80-93.9	29.5	37.4	60.3	29	11.8-24.7	22.8-38.8	37.2-47.4	5,000 1/No	81.75	163/No
Organic Compounds:														
135TNB	0.73	0.126- 0.196	ND- 0.982	ND	ND	ND-1.25	ND	ND	ND	ND-0.318	ND-0.143	--/--	--	--/--
246TNT	26	ND	ND-58	ND	ND	ND-21	ND	ND	0.508- 0.511	ND-0.531	0.26-3.13	--	--	--/--
24DNT	ND	ND	0.401-3	ND	ND	ND	ND	ND	0.0926- 0.458	ND	0.0932- 1.66	--/--	--	--/--
2-Amino-4,6- dinitrotoluene	20	ND	26	ND	ND	ND	ND	ND	0.493	ND	ND	--/--	--	--/--
2-Propanol	NA	NA	NA	NA	NA	NA	NA	NA	NA	40	9	--/--	--	--/--
4-Amino-2,6- dinitroluene	ND	ND	ND	ND	ND	11	0.34	ND	ND	2.5	2.74	--/--	--	--/--
Acetone	NA	NA	39	22	30	8	10	25	ND	ND	ND	--/--	--	--/--
Bis(2-ethylhexyl) phthalate	NA	NA	12	52	53	18	4	1	ND	6-30	10	6/Yes	--	--/--
Benzo[b]fluoranthene	NA	NA	ND	ND	ND	18	ND	ND	ND	ND	ND	0.2/Yes	--	--/--
Chloroform	NA	NA	ND	ND	ND	ND	ND	ND	2.6	ND	ND	100/No	--	--/--
N,N-Diethyl-3- methylbenzamide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4	--/--	--	--/--
Di-n-octyl phthalate	NA	NA	ND	ND	ND	ND	ND	ND	ND	38	ND	--/--	--	--/--
Di-N-butyl phthalate	NA	NA	ND	ND	ND	1	ND	ND	ND	ND	ND	--/--	--	--/--
Diethyl adipate	NA	NA	NA	NA	NA	NA	NA	NA	NA	10	NA	--/--	--	--/--

Table 5.7. Groundwater Results for Monitor Wells Located Near the Sanitary Landfill  
(Page 3 of 3)

Chemical (Depth) 3	MI279	MI280	003	MI264	MI265	004	MI266	MI267	MI062	MI063	MI064	MCL (l g/L)/	Background (l g/L)	2x Background (l g/L)/
	(151 ft) (l g/L)	(295 ft) (l g/L)	(222 ft) (l g/L)	(125 ft) (l g/L)	(295 ft) (l g/L)	(164 ft) (l g/L)	(115 ft) (l g/L)	(295 ft) (l g/L)	(100 ft) (l g/L)	(160 ft) (l g/L)	(247 ft) (l g/L)	Exceeded? (Yes/No)		Exceeded? (Yes/No)
Ethylbenzene	NA	NA	ND	ND	ND	ND	ND	ND	ND	ND-7.5	ND	700/No	--	--/--
HMX	31	ND	ND-17.8	ND	ND	0.878	0.465	ND	0.36	0.254	0.426	--/--	--	--/--
Lauric Acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	10	NA	--/--	--	--/--
Toluene	NA	NA	7	5-6	4	2	3	2	ND	ND	ND	--/--	--	--/--
2-ButaNone/methyl ethyl ketone	NA	NA	13	9	9	ND	ND	8	ND	ND	ND	--/--	--	--/--
Nitrobenzene	ND	ND	ND	ND	ND	0.178	0.258	ND	ND	ND	ND	--/--	--	--/--
Phenol	NA	NA	1	ND	ND	1	1	1	ND	ND	ND	--/--	--	--/--
RDX	310	ND	9.4-430	0.472- 0.605	ND	7-19	3.47	ND	3.21-6.04	0.567-12.4	1.79-6.08	--/--	--	--/--
Tetryl	4.02	ND	ND- 0.999	ND	ND	ND-1.28	ND	ND	ND	ND	ND	--/--	--	--/--
Xylenes,total combined	NA	NA	2	1-2	1	ND	ND	3	ND	ND - 5.9	ND	--/--	--	--/--
Dates Sampled 4	2/95	2/95	10 times between 4/82- 2/86, 11/90, 3/92, 10/94	10/94	10/94	9 times between 6/82- 2/86, 11/90, 3/92, 10/94	10/94	10/94	11/90, 12/92, 8/93, 10/94	11/90, 12/92, 8/93, 10/94	11/90, 12/90, 8/93, 10/94			

Note: -- = not determined; NA = not analyzed; ND = not detected.

- 1 Secondary MCL, 40 CFR, Part 143.
- 2 40 CFR Part 141,action levels in no more than 10 percent of the top samples.
- 3 FDI, 1996.
- 4 All constituents may not have been targeted on all referenced sample dates.

Source: QST.

The Sanitary Landfill is located directly above the groundwater plume emanating from the Open Burning Ground (OBG). Monitor wells located downgradient of the Sanitary Landfill in the shallow regional aquifer (MI062, MI264, and MI266) all indicated contamination by nitrobenzenes. Levels of nitrobenzenes in shallow downgradient monitor wells of the Sanitary Landfill are approximately 1 to 2 orders of magnitude less in concentration than those located within the OBG suggesting that nitrobenzenes detected are associated with the OBG plume of the Sanitary Landfill is a minor source of groundwater contamination. Groundwater contamination originating from the OBG extended beneath the Sanitary Landfill to Route 54, and tends to migrate downward beneath the Sanitary Landfill into the middle portion of the aquifer possibly due to recharge from Ditch 8 located between the Sanitary Landfill and OBG during precipitation events (FDI, 1996).

Elevated levels of bis-2-ethylhexyl phthalate have also been detected in monitor wells downgradient from the landfill. However, similar to explosive related compounds, bis-2-ethylhexyl phthalate has also been detected upgradient of the landfill, indicating that the OBG is a likely source of contamination.

Contaminant levels in shallow monitor wells downgradient of the Sanitary Landfill may be associated with the upper portion of the OBG plume located within the shallow portion of the regional aquifer (FDI, 1996). The southern portion of the OBG plume does not exhibit this downward migration. Sec. 6.0 discusses the environmental significance of the organic constituents detected in groundwater near the Sanitary Landfill. The OBG plume will be addressed as part of the site-wide groundwater operable unit and the southern studies area operable unit.

The MCLs for cadmium and mercury were exceeded at Wells 003 and 004. The regulatory guidance level of lead was also exceeded in Well 003. The cadmium exceedance at Well 003 of 194  $\mu\text{g/L}$  was reported in November 1990. Since that time, two additional samples have been collected from Well 003; a March 1992 sample detected cadmium at 8  $\mu\text{g/L}$ , and an October 1994 sample reported cadmium as less than detection limits. The one previous sample collected at Well 003 (March 1983) also reported a lower level of cadmium (8  $\mu\text{g/L}$ ). Based on this information, it appears that the November 1990 cadmium concentration is an anomaly and could be due to solids related to soil material in the groundwater sample and thus is not considered representative of groundwater.

The cadmium exceedance of 9  $\mu\text{g/L}$  at Well 004 was reported in 1983. Two samples have been collected from this wells since that time, March 1992 (less than 0.1  $\mu\text{g/L}$ ) and October 1994 (4.36  $\mu\text{g/L}$ ), show cadmium present at levels less than the MCL of 5  $\mu\text{g/L}$ .

The maximum cadmium concentration reported at MI063 is 5.33  $\mu\text{g/L}$ . However, another sample pulled on this date was reported at less than 4.01  $\mu\text{g/L}$ . MI063 was sampled two more times.

These results showed cadmium to be less than a detection limit of 7.9  $\mu\text{g/L}$  in December 1992 and less than a detection limit of 4.01  $\mu\text{g/L}$  in August 1993.

The cadmium exceedance of 70.9  $\mu\text{g/L}$  at MI064 was reported in 1990. Since that time, three groundwater samples have been collected (December 1992, August 1993, and October 1994). The analytical results showed cadmium to be present at levels below detection limits.

The mercury exceedances at Wells 003 and 004 both occurred in 1983. Since that time, each well has been sampled once for mercury (November 1990). Mercury was not detected in either sample.

The regulatory guidance level exceedance of lead at Well 003 was reported in 1990. Since that time, two groundwater samples have been analyzed for lead (March 1992 and October 1994). Both samples showed lead levels less than the regulatory guidance level of 15  $\mu\text{g/L}$ .

Cadmium was reported above the MCL of 5  $\mu\text{g/L}$  in Wells 003 and 004 at various times. Recent samples collected from these wells have shown cadmium levels have decreased. However, it is unlikely that the Sanitary Landfill is a source of the historical groundwater contamination at Wells 003 and 004. The 1991 RI report concluded that although contaminants were detected in Wells 003 and 004, given the relative depths of these wells, the small distances between the Sanitary Landfill and the wells, and because soil contamination was not observed, it is unlikely that the Sanitary Landfill is a source of groundwater contamination at these wells (ICF, 1991). In addition to this conclusion, the shallower wells do not exhibit equivalent or higher levels

of contamination, as would be expected if the Sanitary Landfill was a source of groundwater contamination. Other wells considered too deep to monitor contamination from the Sanitary Landfill are MI064, MI267, and MI289.

Sec. 6.0 discusses the environmental significance of the data reported in Table 5-7.

#### **5.2.3.2 Soil**

ICF collected soil samples at the Sanitary Landfill and reported findings in the 1991 RI report (ICF, 1991). Two soil borings were completed to investigate soil contamination resulting from disposal activities currently conducted at MLAAP. Both borings (LF-1 and LF-2) were installed downgradient of the Sanitary Landfill (Fig. 5-6) and drilled to 12 ft. All soil samples were collected and analyzed for selected inorganic and organic chemicals.

Two soil samples were collected near the surface (LF-1 at 0-1 ft and LF-2 at 0-7 ft). These samples were only analyzed for cadmium, chromium, lead, and mercury. Lead was the only targeted metal reported. Data reported in Table 5-8 shows these four metals to be present at low concentrations and less than two times the average site specific background concentration. Based on EPA Guidance (EPA, 1995), site constituents present at concentrations less than two-times the site-specific background concentration do not need further evaluation.

A total of four deeper soil samples were also collected, as identified in Table 5-9 (note the data for LF-2 0 to 7 ft is the same as that presented in Table 5-8). Twelve metals and one organic compound (2-propanol) were reported in deep soil samples collected from the Sanitary Landfill area; these data are summarized in Table 5-9, along with site-specific average background data. Except for aluminum, arsenic, barium, calcium, iron, lead, manganese, magnesium, potassium, silver, and vanadium, all other metals were less than two-times the site-specific background concentrations established for the Southern Study Area (FDI, 1996) or not detected. Based on EPA Guidance (EPA, 1995), site constituents present at concentrations less than two-times the site-specific background concentration do not need further evaluation. Sec. 6.0 discusses the significance of metals as well as 2-propanol reported in the deeper soil samples near the sanitary landfill.

One surface water (08SW01) and one sediment (08SE01) sample were also collected from the Sanitary Landfill area, in Ditch 8 (Fig. 5-7), as part of the 1995 RI effort. Ditch 8 receives surface runoff from various areas (the eastern portion of Area "L", and areas south of Line C), including the OBG. Nitrobenzenes were not detected in the sediment, and heavy metal concentrations were within two-times the established site background levels. Nitrobenzenes were not detected in surface water with the exception of RDX (0.267  $\mu\text{g/L}$ ). The OBG is the likely source of RDX. Heavy metals were detected at levels below regulatory criteria and standards. Surface water samples located downstream indicate levels of HMX and RDX appear to be due to runoff from the OBG (FDI, 1996).

Because Ditch 8 receives runoff from several different areas, it would not be appropriate to represent surface water and sediment data from this location as being attributed to the Sanitary Landfill. For this reason, these data are not presented in this ROD. Ditch 8 will be addressed in a separate ROD (Operable Unit No. 5).

Based on the above discussion, it appears that waste disposal activities at the Sanitary Landfill are not impacting groundwater quality (FDI, 1996).

### **6.0 Human Health and Ecological Evaluation**

#### **6.1 Objectives and Scope of the Health Evaluation**

The objective of this Human Health and Ecological Evaluation is to determine the relative significance of the concentrations of site-related chemicals detected in soil and groundwater at the Salvage Yard, Former ABA, and Sanitary Landfill at MLAAP. The relative significance of site contamination is evaluated by comparing measured site concentrations to medium-specific

Table 5-9. Surface Soil Data Reported for the Sanitary Landfill

	2x Background			
Chemical (depth)	LF- 1 (0 - 1 ft) (mg/kg)	LF-2 (0 - 7 ft) 1 (mg/kg)	Background 2 (mg/kg)	(mg/kg) / Exceeded? (Yes/No)
Inorganic Compounds:				
Aluminum	--	--	12,478.33	24,956.66/No
Antimony	--	--	2.21	4.42/No
Arsenic	--	--	5.03	10.06/No
Barium	--	--	99.37	198.74/No
Beryllium	--	--	0.49	0.98/No
Calcium	--	--	4,317	8,634/No
Cadmium	<3.05	<3.05	1.23	2.46/No
Cobalt	--	--	6.93	13.86/No
Chromium	<12.7	<12.7	16.17	32.34/No
Copper	--	--	21.36	42.72/No
Iron	--	--	14,833.33	29,666.66/No
Lead	17	14.2	15	30/No
Magnesium	--	--	1,459.5	2,919/No
Manganese	--	--	638	1,276/No
Mercury	<0.05	<0.05	0.11	0.22/No
Nickel	--	--	13.06	26.12/No
Potassium	--	--	695.7	1,391.4/No
Selenium	--	--	0.29	0.58/No
Silver	--	--	ND	0/No
Sodium	--	--	225.5	451/No
Thallium	--	--	ND	0/No
Vanadium	--	--	27.38	54.76/No
Zinc	--	--	63.03	126.06/No

Note: -- = not analyzed  
 ND = not detected.

1 Average concentration of original and duplicate samples.

2 FDL, 1996.

Source: QST.



Table 5-9. Subsurface Soil Data Reported for the Sanitary Landfill

Chemical (depth)	LF- 1 (5-9 ft) (mg/kg)	LF-1 (10-12 ft) (mg/kg)	LF-1 (5-9 ft) (mg/kg)	LF-2 (10-12 ft) (mg/kg)	Background 1 (mg/kg)	2x Background (mg/kg) / Exceeded? (Yes/No)
<b>Inorganic Compounds:</b>						
Aluminum	13500 (2)	--	--	13100	5390	10780/Yes
Antimony	<3.8	--	--	<3-8	ND	0/No
Arsenic	5.22 (2)	--	--	1.95	1.73	3.46/Yes
Barium	125 (2)	--	--	106	22.1	44.2/Yes
Beryllium	<1.86	--	--	<1.86	ND	0/No
Calcium	627 (2)	--	--	1370	234	468/Yes
Cadmium	<3.05	<3.05	<3.05	<3.05	ND	0/No
Cobalt	<15	--	--	<15	1.36	2.72/No
Chromium	<12.7	<12.7	<12.7	<12.7	9.27	18.54/No
Copper	<58.6	--	--	<58.6	4.33	8.66/No
Iron	13500 (2)	--	--	13000	5730	11460/Yes
Lead	12.13	6.94	14.2	8.58	2.42	4.84/Yes
Manganese	282	--	--	148	50.3	100.6/Yes
Magnesium	1415 (2)	--	--	1440	370	740/Yes
Mercury	<0.05	<0.05	<0.05	<0.05	ND	0/No
Nickel	<12.6	--	--	<12.6	3.86	7.72/No
Potassium	557	--	--	347	251	502/Yes
Selenium	<0.25	--	--	<0.25	0.26	0.52/No
Silver	0.0559 (2)	--	--	<0.025	ND	0/Yes
Sodium	299	--	--	559	364	728/No
Thallium	<31.3	--	--	<31.3	ND	0/No
Vanadium	40.6 (2)	--	--	43.7	16.1	32.2/Yes
Zinc	<30.2	--	--	<30.2	9.67	19.34/No
<b>Organic Compounds:</b>						
2-Propanol	0.0095	--	--	NR		

Note: -- = not determined.  
ND = not detected.  
NR = not reported.

1 FDI, 1996.

2 Average of two.

Source: QST.

health-based screening levels; if screening levels are exceeded within a medium, then a cumulative risk analysis was performed. The results of the screening and cumulative risk evaluations will be used to determine whether No Further Action is an appropriate response action for the study sites.

This health evaluation has been conducted according to various EPA Region IV and State of Tennessee guidance and is presented in the following sections:

- Data Evaluation/Identification of Chemicals of Potential Concern (COPCs)(Sec. 6.2)
- Exposure Pathway Analysis (Sec. 6.3)
- Health-Based Screening Evaluation (Sec. 6.4)
- Site-Specific Risk-based Screening Results (Sec. 6.5)
- Cumulative Risk Characterization (Sec. 6.6)
- Summary of Risk Screen and Cumulative Risk Results (Sec. 6.7)

## **6.2 Data Evaluation**

COPCs are those hazardous constituents that may have been disposed of or released at a specific site or surrounding environmental media. Identification of COPCs is accomplished by examining historical information available for the area as well as evaluating analytical results of the environmental media sampled at the area. A summary of the historical data evaluated for each site is presented in the following sections.

### **6.2.1 Salvage Yard**

The Salvage Yard was used for the storage of non-hazardous scrap, including casings, machinery, and wood; the presence of trace levels of inorganic and organic chemicals is expected. Thus, any inorganic or organic compound that was detected at this area (except if the detection is the result of laboratory contamination) was included as a COPC for further assessment in the health evaluation. The DA Installation Restoration Data Management Information System (IRDMIS) database and the 1991 RI report (ICF, 1991) were the sources of data evaluated in this health evaluation.

### **6.2.2 Former Ammunition Burnout Area**

The Former ABA was used to demilitarize a wide range of conventional munitions; the presence of trace levels of inorganic and organic compounds is expected. Thus, any inorganic or organic that was detected at this area (except if the detection is the result of laboratory contamination) was included as a COPC for further assessment in the health evaluation. The DA IRDMIS database, the 1991 RI report (ICF, 1991), and the 1996 RI report (FDI, 1996) were used as sources for the health evaluation.

### **6.2.3 Sanitary Landfill**

The Sanitary Landfill is used for the disposal of rubbish and debris from industrial operations for such materials as paper, shipping containers, cardboard boxes, filter pads, and other non-hazardous materials; the presence of trace levels of inorganic and organic compounds is expected. Thus, any inorganic or organic compound that was detected at this area (except if the detection is the result of laboratory contamination) was included as a COPC for further assessment in the health evaluation. The DA IRDMIS database, the 1991 RI (ICF, 1991), and the 1996 RI for Operable Unit No. 5 (FDI, 1996) were used as sources for the health evaluation.

## **6.3 Exposure Pathway Analysis**

An exposure pathway is the route over which a chemical or physical agent migrates from a contaminant source to a receptor(s). The term also describes a unique mechanism by which the receptor may be potentially exposed to chemicals originating from the site. For an exposure pathway to be complete, the following four elements must be present:

- A source or release from a source (e.g., chemicals disposed of in soil);
- A likely environmental migration route (e.g., infiltration of chemicals from soil to groundwater);

- An exposure point where receptors may come in contact with site-related chemical (e.g., direct exposure to site soil); and
- A route by which potential receptors may be exposed to a site-related chemical (e.g., ingestion, inhalation, or dermal absorption).

If any of these four elements is not present, the exposure pathway is considered incomplete and is not expected to contribute to the total exposure from the site.

#### **6.3.1 Human Exposure Pathways**

A point of human exposure is the location where an exposed population or individual (receptor) can come into contact with the subject contamination. The potential point of exposure to hazardous constituents is assumed to be directly at or within the boundary of each of the three study areas.

The future land use of MLAAP is designated as industrial use. However, to ensure that the health-based screening evaluation is protective of human health, the most stringent unrestricted land-use (residential) conditions were considered when comparing residual site concentrations to residential health-based levels. The risk evaluation also compares residual site concentrations to industrial health-based levels. These levels associated with industrial use are higher because an industrial exposure scenario results in much lower exposure potential than the residential exposure scenario. Because a construction exposure scenario could occur at some unforeseen time in the future, all three study sites were evaluated under this scenario as well, whereby the subsurface soil concentrations are screened against the industrial health-based level.

#### **6.3.2 Ecological Exposure Pathways**

Ecological exposure to residual site contaminants in soil is expected to be incomplete or insignificant due to the absence of quality habitat at the ABA and Salvage yard, as well as low levels of contamination at the Sanitary landfill (e.g., levels are near or below detection limits). As presented in Sec. 5.0, many constituents detected in all soil samples were generally less than two-times the average site-specific background concentrations.

With respect to habitat, the Salvage Yard provides little to virtually no habitat for any terrestrial receptor due to the presence of nonhazardous scrap, including casings, machinery, and wood stored in bins or in piles (ICF, 1991). The Former ABA also does not provide habitat for terrestrial receptors as this area consists of various concrete aprons and barricaded buildings, an earth-covered igloo, and an office building. In fact, the Former ABA is currently used as a pistol firing range, which would be avoided by larger terrestrial receptors (ICF, 1991). While the Sanitary Landfill could provide habitat for small mammals such as small rodents (e.g., rabbits or mice), exposure to contaminants in the surface soil, which included samples collected from 0 to 2 ft, is expected to be insignificant due to the fact that only one metal, lead, was reported above detection limits at a concentration that is less than two-times background.

In addition, due to the explosive hazard associated with the mission at NULAAP, large buffer zones are located outside of the production and disposal areas; these large buffer areas provide suitable habitat for terrestrial ecological receptors. Due to the availability of such habitat outside the smaller study areas under evaluation, low level terrestrial ecological exposure was considered insignificant and was excluded from further evaluation in this health evaluation and thus, no risk characterization was performed for terrestrial exposure to these study sites.

### **6.4 Health-Based Screening Evaluation**

Once data evaluation has been completed and relevant exposure routes and pathways have been defined, the concentrations of COPCs are then evaluated in a health-based screening. According to EPA Region IV guidance (EPA, 1995), the purpose of conducting a health-based screen is to determine if any of the COPCs should be included in a comprehensive site-specific baseline risk assessment. The screening process included the following steps:

- Risk-Based Concentration Screen,
- Nutritional Essentiality, and

- Comparison to Background Concentrations.

#### **6.4.1 Risk-Based Concentration Screen**

The first step in the health-based screening is to compare the maximum detected site concentrations to a risk-based concentration (RBC). EPA Region IV has adopted the RBCs developed by Region III for soil, drinking water, air, and fish tissue (EPA, 1995). The RBCs developed by Region III were derived based on default exposure scenarios to include residential and industrial, and a target hazard index (HI) or lifetime cancer risk of 0.1 or  $1 \times 10^{-6}$ , respectively. The EPA established RBCs for soil and groundwater are presented in Table 6-1 along with the relevant toxicity values upon which they are based. The algorithms used by EPA to calculate the RBCs are presented in Appendix B. Because not all chemicals detected at the site have EPA established toxicity values upon which to derive RBCs, provisional RBCs were developed based on toxicity information available from peer reviewed literature. These provisional levels were derived using EPA methods, and serve as guidance levels in the absence of EPA established RBCs for such compounds (Table 6-2). While using these provisional values for screening purposes adds a level of uncertainty to the screening process, excluding these chemicals from the process is adding even more uncertainty to the screening process, as exclusion does not allow for a quantitative confirmation whether such chemicals contribute significantly or not to the overall risk at a study site.

The health-based screening entails comparing the maximum detected value at the site to the RBC and regulatory established value, if available. For the three study areas, only soil and groundwater data were evaluated. Only one surface water sample has been collected at the three sites, and the relevance of this data is discussed in the Sec. 6.5.3 (Sanitary Landfill).

The RBC screening process used is as follows (EPA, 1995):

- The maximum relevant concentration of each chemical detected in each medium is compared to the appropriate RBC (Note: Some historical maximum concentrations are no longer considered relevant and, thus, were not used in the evaluation.)
- If the maximum concentration exceeds the RBC for that medium, the chemical is retained for further evaluation in a baseline health risk assessment (HRA) to assess all exposure routes involving that medium; otherwise, the chemical is not further evaluated for that medium.
- If a chemical does not exceed its RBC in any medium, the chemical is not further evaluated in the HRA.

For the residential and industrial soil screening evaluation, the maximum site concentrations detected in surface soil (e.g., 0 to 2 ft) are compared to the residential- and industrial-based screening values, respectively. Because the industrial scenario represents a more conservative scenario than a construction scenario, the industrial RM are compared to the maximum chemical concentrations detected in subsurface soil (> 2 ft) to represent the construction scenario for screening purposes.

#### **6.4.2 Nutritional Essentiality**

According to EPA region-wide guidance (1989) and Region IV guidance (EPA, 1995) compounds that are essential human nutrients need not be considered further in the quantitative risk assessment. According to Region IV these include calcium, chloride, iodine, magnesium, phosphorus, potassium, and sodium. If an inorganic compound detected in soil at the site was an essential nutrient, it was excluded from consideration to be included in a HRA.

#### **6.4.3 Background Comparison**

EPA Region IV guidance (1995) states, For naturally occurring inorganics and radionuclides, compare the onsite maximum detected concentration to 2 times the average site-specific background concentration. Eliminate the chemical as a COPC if it is less than 2 times the background level.

Results of the health-based screening evaluation for soil and groundwater at each area are presented in the following section.

**Table 6-1. Summary of EPA Region IV Risk-Based Concentrations Used for Screening**

Risk-Based Concentrations										
Contaminant	CAS	RfDo	RfDI	CPSo	CPSI	V	Tap	Soil Ingestion		Source
		mg/kg/d	mg/kg/d	kgôd/mg	kgôd/mg		Water	Industrial	Residential	
mg/kg										
mg/kg										
INORGANICS										
Aluminum	7429905	1.0E+00	-	NA	NA		3.7E+03 N	2.0E+05 N	7.8E+03 N	EPA
Antimony	7440360	4.0E-04	-	NA	NA		1.5E+00 N	8.2E+01 N	3.1E+00 N	EPA
Arsenic (as carcinogen)	7440382	-	-	1.5E+00	1.5E+01		4.5E-02 C	3.8E+00 C	4.3E-01 C	EPA
Barium and compounds	7440393	7.0E-02	1.4E-04	NA	-		2.6E+02 N	1.4E-04 N	5.5E+02 N	EPA
Beryllium and compounds	7440417	5.0E-03	-	4.3E+00	8.4E+00		1.6E-02 C	1.3E+00 C	1.5E-01 C	EPA
Cadmium and compounds	7440439	5.0E-01	5.7E-05	-	6.3E+00		1.8E+00 N	1.0E+02 N	3.9E+00 N	EPA
Chromium VI and compounds	18540299	5.0E-03	-	-	4.2E+01		1.8E+01 N	1.0E+03 N	3.9E+01 N	EPA
Cobalt	7440484	6.0E-02	-	NA	NA		2.2E+02 N	1.2E+04 N	4.7E+02 N	EPA
Copper and compounds	7440508	4.0E-02	-	NA	NA		1.5E+02 N	8.2E+03 N	3.1E+02 N	EPA
Iron	7439896	3.0E-01	-	NA	NA		1.1E+03 N	6.1E+04 N	2.3E+03 N	EPA
Lead	7439921	-	-	NA	NA		1.5E+01 M	1.0E+03 L	4.0E+02 O	EPA
Manganese and compounds	7439965	2.3E-02	1.4E-05	NA	NA		8.4E+01 N	4.7E+03 N	1.8E+02 N	EPA
Mercury (inorganic)	7439976	3.0E-04	8.6E-05	NA	NA		1.1E+00 N	6.1E+01 N	2.3E+00 N	EPA
Nickel and compounds	7440020	2.0E-02	-	NA	NA		7.3E+01 N	4.1E+03 N	1.6E+02 N	EPA
Selenium	7782492	5.0E-03	-	NA	NA		1.8E+01 N	1.0E+03 N	3.9E+01 N	EPA
Silver and compounds	7440224	5.0E-03	-	NA	NA		1.8E+01 N	1.0E+03 N	3.9E+01 N	EPA
Thallium	7446156	3.0E-05	-	NA	NA		2.9E-01 N	1.6E+01 N	6.3E-01 N	EPA
Vanadium	7440622	7.0E-03	-	NA	NA		2.6E+01 N	1.4E+03 N	5.5E+01 N	EPA
Zinc	7440666	3.0E-01	-	NA	NA		1.1E+03 N	6.1E+04 N	2.3E+03 N	EPA
ORGANICS										
Acetone	67641	1.0E-01	-	NA	NA		3.7E+02 N	2.0E+04	7.8E+02 N	EPA
Benzo(b)fluoranthene	205992		-	7.3E-01	6.1E-01		9.2E-02 C	7.8E+00 C	8.7E-01 C	EPA
Bis(2-ethylhexyl)phalate(DEHP)	117817	2.0E-02	-	1.4E-02	-		4.8E+00 C	4.1E+02 C	4.6E+01 C	EPA
Chloroform	67663	1.0E-02	-	6.1E-03	8.1E-02	x	1.5E-01 C	9.4E+02 C	1.0E+02 C	EPA
Dibutyl phthalate	84742	1.0E-01	-	NA	NA		3.7E+02 N	2.0E+04 N	7.8E+02 N	EPA
1,3-Dinitrobenzene	99650	1.0E-04	-	NA	NA		3.7E-01 N	2.0E+01 N	7.8E-01 N	EPA
Dinitrotoluene mixture	ND		-	6.8E-01	-		9.8E-02 C	8.4E+00 C	9.4E-01 C	EPA
2,4-Dinitrotoluene	121142	2.0E-03	-	NA	NA		7.3E+00 N	4.1E+02 N	1.6E+01 N	EPA
2,6-Dinitrotoluene	606202	1.0E-03	-	NA	NA		3.7E+00 N	2.0E+02 N	7.8E+00 N	EPA
Di-n-Octyl phthalate	117840	2.0E-02	-	NA	NA		7.3E+01 N	4.1E+03 N	1.6E+02 N	EPA
Di-N-octyladipate	123795		-	NA	NA		ND	-	-	EPA
1,2-Epoxy cyclohexene	ND		-	NA	NA		ND	-	-	EPA
Ethylbenzene	100414	1.0E-01	2.9E-01	NA	NA	x	1.3E+02 N	2.0E+04 N	7.8E+02 N	EPA
Hexahydro-1,3,5-trinitro-1,3,5-triazine(RDX)	121824	3.0E-03	-	1.1E-01	-		6.1E-01 C	5.2E+01 C	5.8E+00 C	EPA
Methyl ethyl ketone	78933	6.0E-01	2.9E-01	NA	NA	x	1.9E+02 N	1.2E+05 N	4.7E+03 N	EPA
Nitrobenzene	98953	5.0E-04	5.7E-04	NA	NA	x	3.4E-01 N	1.0E+02 N	3.9E+00 N	EPA
Octahydro-1357-tetranitro-1357-tetrazocine(HMX)	2691410	5.0E-02	-	NA	NA		1.8E+02 N	1.0E+04 N	3.9E+02 N	EPA
Toluene	108883	2.0E-01	1.1E-01	NA	NA	x	7.5E+01 N	4.1E+04 N	1.6E+03 N	EPA
Trichlorofluoromethane	75694	3.0E-01	2.0E-01	NA	NA		1.3E+02 N	6.1E+04 N	2.3E+03 N	EPA
1,3,5-Trinitrobenzene	99354	5.0E-05	-	NA	NA		1.8E-01 N	1.0E+01 N	3.9E-01 N	EPA
Trinitrophenylmethylnitramine	479458	1.0E-02	-	NA	NA		3.7E+01 N	2.0E+03 N	7.8E+01 N	EPA
2,4,6-Trinitrotoluene	118967	5.0E-04	-	3.0E-02	-	x	2.2E+00 C	1.9E+02 C	2.1E+01 C	EPA
Xylene (mixed)	1330207	2.0E-00	-	NA	NA	x	1.2E+03 N	4.1E+05 N	1.6E+04 N	EPA

Note: CAS. = Chemical Abstract Number.  
RfDo = Oral Reference Dose.  
RfDI = Inhalation Reference Dose.  
CSFo = Oral cancer slope factor (mg/kg/day)-1  
CSFi = Inhalation cancer slope factor (mg/kg/day)-1  
C = Carcinogenic affects.  
N = Noncarcinogenic effects.

M = Action level under the Safe Drinking Water Act.  
EPA = Risk-Based Concentration Table, Jan.-Jun 1996, Region III. Philadelphia, PA,  
V = Volatile compound.  
L = EPA Region IX Preliminary Remedial Goal for Lead at Industrial Sites. August, 1996.  
ND or - = Not determined.  
NA = Does not apply.  
O = EPA Region IX Preliminary Remedial Goal for Lead at Residential Sites. August 1996,

Source: QST.

Table 6-2. Summary of Screening Values Based on Provisional Toxicity Information.

Contaminant	CAS	RfDo mg/kg/d	RfDi mg/kg/d	Cpso kgöð/mg	Risk-Based Concentrations				Residential mg/kg	Source
					CPSi kgöð/mg	V	Tap	Soil Ingestion		
							Water ug/L	Industrial mg/kg		
Inorganic Compounds:										
Calcium	7440702	1.1E+01	-	-	-		4.2E+04 N	>1.0E+06 N	8.9E+04 N	RDA
Magnesium	7439954	2.9E+00	-	NA	NA		1.0E+04 N	5.8E+05 N	2.2E+04 N	RDA
Potassium	7440097	2.9E+01	-	NA	NA		1.0E+05 N	>1.0E+06 N	2.2E+05 N	RDA
Sodium	7440235	7.1E+00	-	NA	NA		2.6E+04 N	>1.0E+06 N	5.6E+04 N	RDA
Organic Compounds:										
2-Amino-4,6-dinitrotoluene	35572782	1.4E-02 P	-	NA	NA		5.1E+01 N	2.9E+03 N	1.1 E+02 N	Prov
4-Amino-2,6-dinitrotoluene	19046510	9.6E-03 P	-	NA	NA		3.5E+01 N	2.0E+03 N	7.5E+01 N	Prov
2-Cyclohexen-1-ol	see 30687	2.2E-03 P	-	NA	NA		8.0E+00 N	4.5E+02 N	1.7E+01 N	Prov
2-Cyclohexen-1-one	30687	2.2E-03 P	-	NA	NA		8.0E+00 N	4.5E+02 N	1.7E+01 N	Prov
Lauric Acid	143077	1.2E-01 P	-	NA	NA		4.4E+02 N	2.5E+04 N	9.4E+02 N	Prov
N,N-diethyl-3-methylbenzamide	134623	2.0E-02 P	-	NA	NA		7.3E+01 N	4.1E+03 N	1.6E+02 N	Prov
2-Propanol	67630	8.0E-02 P	-	NA	NA		2.9E+02 N	1.6E+04 N	6.3E+02 N	Prov
Palmitic Acid	57103	1.0E-01 P	-	NA	NA		3.7E+02 N	2.0E+04 N	7.8E+02 N	Prov

Note: CAS. = Chemical Abstract Number.  
RfDo = Oral Reference Dose.  
RfDi = Inhalation Reference Dose.  
CSFo = Oral cancer slope factor (mg/kg/day)-1  
CPSi = Inhalation cancer slope factor (mg/kg/day)-1  
C = Carcinogenic effects.  
N = Noncarcinogenic effects.  
EPA = Risk-Based Concentration Table, Jan.-Jun 1996. Region III. Philadelphia, PA.  
P = Provisional RfD based on LD50/100,000 from Registry of Toxic Effects of Chemical Substances, 1996.  
RDA = Recommended daily allowance for adult/70 kg to derive an RfD upon which to base the RBC.  
L = EPA Region IX Preliminary Remedial Goal for Lead at Industrial Sites, August, 1996.  
Prov. = Screening level based on provisional RfD.  
ND or - = Not determined.  
NA = Does not apply.

Source: QST.

## **6.5 Site-Specific Risk-Based Screening Results**

To determine the relative significance of the residual site-related contamination detected in groundwater and soil at each study area, a health-based screening approach was used, as described previously. If the site concentrations are deemed significant (e.g. exceed screening levels) then these chemicals and associated media are addressed further in a cumulative risk evaluation.

For soil, the maximum concentrations for each detected compound were compared to the EPA residential and industrial RBCs and background concentrations. Even if a chemical exceeds an RBC, if the concentration is below two-times the site-specific background concentration, then the chemical is not determined to be site-related and does not require any further action. In addition, if a compound is an essential nutrient as outlined by EPA Region IV (e.g., calcium, chloride, iodine, magnesium, phosphorus, potassium, and sodium) (EPA, 1995), the chemical does not require further action.

For groundwater, the maximum detected groundwater concentrations (unfiltered) were compared to the RBC, MCL, and background concentrations. As with soils, even if a compound exceeds an RBC or MCL, if the concentration is below two-times the average background concentration, then the chemical is not determined to be site-related and does not require any further action. In addition, if a chemical is an essential nutrient as outlined by EPA Region IV (e.g., calcium, chloride, iodine, magnesium, phosphorus, potassium, and sodium), then the chemical does not require further action. Finally, if a groundwater constituent is present at levels less than MCLs, as well as two-times background it is assumed that this chemical would not warrant further evaluation. However, if a compound is below an MCL but exceeds two-times background or an RBC, the compound will be further retained for cumulative risk analysis, because an MCL is not a purely risk-based value.

The screening results for each study area are summarized in the following subsections.

### **6.5.1 Salvage Yard**

#### **6.5.1.1 Groundwater**

As shown in Table 6-3, 13 inorganics and no organics were detected in the one monitor well (MI035) located downgradient from the Salvage Yard. Except for cadmium and mercury, all 11 metals reported in Table 6-3 were reported at levels less than MCLs, RBCs, and/or less than two-times the average site-specific background concentrations established for the site, or were considered essential nutrients. The maximum levels detected for cadmium and mercury were reported in 1983. Since that time, MI035 was sampled four more times. Cadmium was targeted for all four sampling efforts, and mercury was targeted twice and most recently, Cadmium was detected at a concentration of 3.68 ug/L in September 1988; it was not detected in sampling events conducted in January 1989, October 1990, and April 1997. Mercury was not detected in either of the two sampling events (October 1990 and April 1997) where it was a targeted analyte. Results of these analyses show cadmium and mercury to be present at concentrations less than MCLs and less than two-times the site-specific background concentrations established for the site.

Because MCLs are not strictly health-based values, concentrations below MCLs are not the determining factor for supporting a No Further Action recommendation. To support no further action for such an instance, these constituents must also be below two-times background or RBCs; this is the case for barium, cadmium, chromium, copper, mercury, and manganese, therefore these chemicals did not require further cumulative risk evaluation.

Based on this information, the groundwater at this site does not required further action.

Table 6-3. Comparison of Residual Groundwater Contamination at the Salvage Yard to MCLs, Risk-based Concentrations, and Background

Analyte	Maximum Conc. in M1035 (ug/L)a	April '97 Resample M1035	RBC (ug/L)	MCL	Average Background++	RBC or MCL Exceeded? (Y/N)	Site > 2x Avg. Bkg.? (Y/N)	Essential Nutrient? (Y/N)	Health Concern? (Y/N)	<2XBG	<MCL	Reason for NFA (1) ESS Nutrient		Note References
Aluminum	ND	137	3700	200 SMC	27750	N/NA	N	N	N	X		X		
Barium	43	45.1	260	2000	81.5	N/N	N	N	N	X	X	X		
Cadmium	41*	1.51+	1.8	5	BDL	N/N	N	N	N	X	X	X		
Calcium	6740	6330	42000	ND	19100	N/ND	N	Y	N	X		X	X	
Chromium	13	3.48+	18	100	21.3	N/N	N	N	N	X	X	X		
Copper	12.9	2.5+	150	1300	35.7	N/N	N	N	N	X	X	X		
Iron	ND	312	1100	300 SMC	18450	N/NA	N	Y	N	X		X	X	
Lead	ND	1.41	ND	15	BDL	NA/N	N	N	N		X	X		
Mercury	3.3**	0.121+	11.11	2	BDL	N/N	N	N	N		X	X		
Magnesium	2340	1540	10000	ND	6855	N/ND	N	Y	N	X		X	X	
Manganese	5.91	7.3	84	50 SMCL	231.5	N/N	N	N	N	X	X	X		
Potassium	1980	2390	100000	ND	2240	N/ND	N	Y	N	X		X	X	
Sodium	3660	3650	26000	ND	33050	N/ND	N	Y	N	X		X	X	

Note: BDL = below detection limit.  
ND = not determined.

+ below detection , value shown is 1/2 detection limit for risk-based screening purposes.

a Maximum detection concentration in events conducted prior to 1991.

\* Maximum detected value is from M1035 during sampling event of 3/83. Subsequent samples collected in 9/88, 11/89, 10/90, and 4/97 show that cadmium is below the MCL.

\*\* Maximum detected value from M1035 during sampling event of 3/83. Subsequent samples collected in 10/90 and 4/97 show that mercury is below the MCL and not detected.

++ Results from M1229 in the RI Report on OU4, Northern Study Area, conducted by ERM. 1995.

1 Based on April 1997 data from M1035 which was resampled due to the historical presence of cadmium and mercury above MCLs.

Source: QST.



#### **6.5.1.2 Surface Soil**

As shown in Table 6-4, 21 metals and one organic compound were reported in surface soils above detection limits at the Salvage Yard. Except for beryllium, cadmium, chromium, copper, iron, lead, thallium, and zinc, concentrations of these compounds were either below the RBCs, two-times the site-specific background soil concentrations, or the chemical was considered an essential nutrient.

The 1991 RI concluded that the Salvage Yard was not a source of groundwater contamination (ICF, 1991). This conclusion is confirmed when evaluating the soils and groundwater data for the Salvage Yard.

Based on the information presented in this section (6.5.1.2), No Further Action cannot be considered as an appropriate response until a cumulative risk evaluation is performed on the eight metals exceeding the RBCs in surface soil (see Sec. 6.6).

#### **6.5.1.3 Subsurface Soil**

As shown in Table 6-5, 12 metals and four organic compounds were reported above detection limits in subsurface soils at the Salvage Yard. The subsurface site data presented in Table 6-5 were compared to both residential and industrial RBCs in order to be consistent with the surface soil screen. However, as the subsurface soils are deeper than 1 ft, residential exposure to these soils is unlikely. Therefore, the residential RBC was not considered relevant to subsurface soils.

Except for arsenic, the concentrations of these compounds were either below the industrial RBCs, two-times the site-specific background soil concentrations, or the chemical was considered an essential nutrient.

Based on the information presented in this section (6.5.1.3), No Further Action cannot be considered as an appropriate response until a cumulative risk evaluation is performed on arsenic, which exceeded the industrial RBC in subsurface soil (see Sec. 6.6).

### **6.5.2 Former Ammunition Burnout Area**

#### **6.5.2.1 Groundwater**

As shown in Table 6-6, 20 inorganic and 6 organic compounds were reported above detection limits. Several metals were detected at concentrations exceeding RBCs, MCLs, or two-times the site-specific background concentrations; however, for reasons explained in Sec. 5.2.2.1 and in Table 6-6, these elevated levels were considered to be unrepresentative. When these data were excluded from consideration, all remaining detected constituents (metals and organic compounds) were either below two-times the site-specific background concentration, RBCs or less than MCLs, or were considered acceptable because the constituent was considered an essential nutrient.

Because MCLs are not strictly health-based values, concentrations below MCLs were not the determining factor for supporting a No Further Action recommendation. To support no further action for such an instance, these compounds must also be below two-times background or RBCs. As shown in Table 6-6, three inorganic compounds (beryllium, cadmium, and chromium) and one organic compound (bis-2-ethylhexylphthalate) were less than their MCLs, but they exceeded background or RBCs. Thus, these chemicals were included in a cumulative risk evaluation in order to determine if groundwater at this area requires further action. Nitrobenzene and 1,3,5-trinitrobenzene do not have MCLs; however, these constituents were detected above background concentrations. Therefore, these chemicals were also included in the cumulative risk characterization.

Table 6-4. Comparison of Residual Surface Soil Contamination at the Salvage Yard to RBCs and Background Concentrations

Analyte	Maximum Detected Conc. (ug/g)	Sample ID (0-1 ft)	RBC (mg/kg)		Average Background+	Site > 2x Avg. Bkg.? (Y/N)	Chemical Essential Nutrient? (Y/N)	Site> RBCs Res. or Ind.?		Health Concern? (Y/N)	Reason for NFA				Note Reference	
			Residential	Industrial				Res.	or		Ind.?	<2XBG	<MCL	<RBC		ESS Nutrient
Inorganic Compounds:																
Aluminum	4495	SYD-2	7800	200000	12478	N	N	N/N		N	X		X			
Antimony	3.57*	SYD-2	3.1	82	2.2	N	N	Y/N		N	X		X	1		
Arsenic	5.97	SYD-2	0.43	3.8	5	N	N	Y/Y		N	X					
Barium	186	SYD-2	550	14000	99	N	N	N/N		N	X		X			
Beryllium	1.62	SYD-2	0.15	1.3	0.49	Y	N	Y/Y		N				2		
Cadmium	29.5	SYD-2	3.9	100	1.23	Y	N	Y/N		N			X	1,3		
Calcium	5500	SYD-2	89000	>1E+06	4317	N	Y	N/N		N	X		X			
Chromium	75.2	SYD-2	39	1000	16.2	Y	N	Y/N		N			X	1,3		
Cobalt	6.04	SYD-2	470	12000	6.93	N	N	N/N		N	X		X			
Copper	13000	SYD-1	310	8200	21.36	Y	N	Y/N		N				3		
Iron	45200	SYD-2	2300	61000	14833	Y	N	Y/N		N			X	1,3		
Lead	639	SYD-2	400	1000	15	Y	N	Y/N		N			X	1,3		
Magnesium	741	SYD-2	22000	580000	1459	N	Y	N/N		N	X		X			
Manganese	494	SYD-2	180	4700	638	N	N	Y/N		N	X		X			
Mercury	0.343	SYD-2	2.3	61	0.11	Y	N	N/N		N			X			
Nickel	34.8	SYD-2	160	4100	13.1	Y	N	N/N		N			X			
Potassium	368	SYD-1	220000	>1E+06	695	N	Y	N/N		N	X		X			
Selenium	0.12*	SYD-2	39	1000	0.29	N	N	N/N		N	X		X			
Silver	2.35	SYD-2	39	1000	BDL	Y	N	N/N		N			X			
Sodium	464	SYD-2	560000	>1E+06	225	Y	Y	N/N		N			X			
Thallium	39.1	SYD-2	0.63	16	0.9	Y	N	Y/N		N				3		
Vanadium	16.4	SYD-2	55	1400	27.4	N	N	N/N		N	X		X			
Zinc	2495	SYD-2	2300	61000	63	Y	N	Y/N		N			X	1,3		
Organic Compounds:																
RDX	0.172	SYD-2	5.8	52	NA	NA	N	N/N		N			X			

Note: BDL = below detection limit.  
NA = not analyzed.  
RBC = risk-based concentration.

- \* Analyte is below detection; value shown is 1/2 detection limit for risk-based screening purposes.  
+ Background concentration was obtained from RI completed by FDI (1996).  
1 Although RBC for residential scenario was exceeded, max, concentration was less than industrial RBC.  
2 Included for cumulative risk evaluation (see Table 6-12).  
3 Included for cumulative HI evaluation (see Table 6-12).

Source: QST.

Table 6-5. Comparison of Residual Subsurface Soil Contamination at the Salvage Yard to RBCs and Background Concentrations

Analyte	Maximum	Sample ID	RBC		Subsurface	Site >	Chemical	Site>	Health	Reason for NFA				Note	
	Detected	and	(mg/kg)		Average	2x Avg.	Essential	RBCs		Concern?	<2XBG	<MCL	<RBC		ESS
	Conc. (ug/g)	Depth (ft)	Residential	Industrial	Background	Bkg.?	Nutrient?	Res. or Ind.?							
Inorganic Compounds															
Aluminum	11000	SYD-2(5-7 ft)	7800	200000	5390	Y	N	Y/N	N			X		1	
Antimony	1.9*	SYD-1,2(5-7 ft)	3.1	82	BDL	N	N	N/N	N	X		X			
Arsenic	4.64	SYD-1(5-7 ft)	0.43	3.8	1.73	Y	N	Y/Y	N					2	
Barium	139	SYD-2(5-7 ft)	550	1400	221	Y	N	N/N	N			X			
Beryllium	0.93*	SYD-1,2(5-7 ft)	0.15	1.3	BDL	N	N	Y/N	N	X		X		1	
Cadmium	1.52*	SYD-1,2(5-7 ft)	3.9	100	BDL	N	N	N/N	N	X		X			
Calcium	854	SYD-1(5-7 ft)	89000	>1E+06	234	Y	Y	N/N	N			X	X		
Chromium	6.35*	SYD-1,2(5-7 ft)	39	1000	9.27	N	N	N/N	N	X		X			
Cobalt	7.5*	SYD-1,2(5-7 ft)	470	12000	1.36	Y	N	N/N	N			X			
Copper	29.3*	SYD-1,2(5-7 ft)	310	8200	4.33	Y	N	N/N	N			X			
Iron	11000	SYD-1(5-7 ft)	2300	61000	5730	N	N	Y/N	N	X		X		1	
Lead	18	SYD-1(5-7 ft)	400	1000	2.42	Y	N	N/N	N			X			
Magnesium	1920	SYD-1(5-7 ft)	22000	580000	370	Y	Y	N/N	N			X	X		
Manganese	984	SYD-1(5-7 ft)	180	4700	50.3	Y	N	Y/N	N			X		1	
Mercury	0.025*	SYD-1,2(5-7 ft)	2.3	61	BDL	N	N	N/N	N	X		X			
Nickel	6.3*	SYD-1,2(5-7 ft)	160	4100	386	N	N	N/N	N	X		X			
Potassium	492	SYD-2(5-7 ft)	220000	>1E+06	251	N	Y	N/N	N	X		X	X		
Selenium	0.12*	SYD-1,2(5-7 ft)	39	1000	0.26	N	N	N/N	N	X		X			
Silver	0.313	SYD-1(5-7 ft)	39	1000	BDL	Y	N	N/N	N			X			
Sodium	414	SYD-1(5-7 ft)	560000	>1E+06	364	N	Y	N/N	N	X		X	X		
Thallium	15.6*	SYD-1,2(5-7 ft)	0.63	16	BDL	N	N	Y/N	N	X		X		1	
Vanadium	34.5	SYD-1(5-7 ft)	55	1400	16.1	Y	N	N/N	N			X			
Zinc	15.1*	SYD-1,2(5-7 ft)	2300	61000	9.67	N	N	N/N	N	X		X			
Organic Compounds:															
Acetone	0.061	SYD-2(5-7 ft)	780	20000	NA	NA	N	N/N	N			X			
2-Propanol	0.24	SYD-2(5-7 ft)	625	16600	NA	NA	N	N/N	N			X			
Toluene	0.12	SYD-1(5-7 ft)	1600	41000	NA	NA	N	N/N	N			X			
Trichlorofluoromethane	0.0064	SYD-1(5-7 ft)	2300	61000	NA	NA	N	N/N	N			X			

Note: = below detection limit.

NA = not available.

RBC = risk-based concentration.

\* Analyte is below detection; value shown is 1/2 detection limit for risk-based screening purposes.

+ Background was obtained from RI completed by FDI (1996).

1 Screening against industrial RBC is considered relevant, because soils are deeper than 1 ft; therefore, residential exposure to these soils is unlikely.

2 Included for cumulative risk evaluation (see Table 6-13).

Source: QST.

Table 6-6. Comparison of Residual Groundwater Contamination at Former ABA to MCLs, RBCs, and Background Concentrations

	Maximum Detected	Monitor	RBC		Average	RBC or MCL	Site > 2x	Essential	Health		Reason for NFA				
Analyte	Conc. (ug/L)*	Well	(ug/L)	MCL	Background+	Exceeded? (Y/N)	Avg. Bkg.? (Y/N)	Nutrient? (Y/N)	Concern? (Y/N)	<2XBG	<MCL	<RBC	ESS Nutrient	Note Reference	
Inorganic Compounds:															
Aluminum	9500	M1228	3700	200 SMCL	27750	Y/Y	N	N	N	X					
Arsenic	3.09	M1228	0.045	50	6.075	Y/N	N	N	N	X	X				2
Barium	123	M1227	260	2000	81.5	N/N	N	N	N	X	X	X			
Beryllium	0.65	M1227	0.016	4	BDL	Y/N	Y	N	N		X				2
Cadmium	23.2(3.14)	M1073(M1226)	1.8	5	BDL	Y(N)/Y(N)	Y(Y)	N	N		X				1
Calcium	6800	M1232	42000	ND	19100	N/ND	N	Y	N	X		X	X		
Chromium	36.1	M1227	18	100	21.3	Y/N	N	N	N		X				2
Cobalt	5.11	M1227	220	ND	BDL	N/ND	Y	N	N			X			
Copper	22.8	M1232	150	1300	35.7	N/N	N	N	N	X	X	X			
Iron	12700	M1228	1100	300 SMCL	18450	Y/N	N	N	N	X					
Lead	16.6	M1232	ND	15	12.85	ND/Y	N	N	N	X					
Magnesium	2370	M1232	10000	ND	6855	N/ND	N	Y	N	X		X	X		
Manganese	219	M1232	84	50 SMCL	231.5	Y/Y	N	N	N	X					
Mercury	0.232	M1226	1.1	2	BDL	N/N	Y	N	N		X	X			
Nickel	33.2	M1227	73	100	BDL	N/N	Y	N	N		X	X			
Potassium	5660	M1228	100000	ND	2240	N/ND	Y	Y	N				X		
Selenium	1.9	M1227	18	50	BDL	N/N	Y	N	N		X	X			
Sodium	13900	M1228	26000	ND	33050	N/ND	N	Y	N	X		X	X		
Vanadium	55.8	M1232	26	ND	50.1	Y/ND	N	N	N	X					
Zinc	67.2	M1228	1100	5000 SMCL	81.75	N/N	N	N	N	X	X	X			
Organic Compounds:															
Bis-2-ethylhexylphthalate	5.7	M1073	4.8	6	NA	Y/N	NA	N	N		X				2
1,3-Dinitrobenzene	0.893	M1227	1.5	ND	NA	N/ND	NA	N	N		X	X			
Nitrobenzene	0.596	M1226	0.34	ND	NA	Y/ND	NA	N	N						2
1,3,5-Trinitrobenzene	0.285	M1227	0.18	ND	NA	Y/ND	NA	N	N						2
HMX	1.69	M1226	180	ND	NA	N/ND	NA	N	N			X			
RDX	0.422	M1228	0.61	ND	NA	N/ND	NA	N	N			X			

Note: BDL = below detection level.  
MCL = maximum contaminant level for drinking water to protect human health.  
NA = not available.  
ND = not determinined.  
SMCL = secondary maximum contaminant level for drinking water to address odor, color, and taste.

\* Maximum detected value from wells M1226, -1227, -1228, M1073, and M1232. M1233 was not considered as this well was screened in fine sand, results show constituent concentrations indicative of soil material collected with groundwater. During sampling, M1233 was purged until dry several times; therefore, this well is considered an inadequate supply of groundwater. Additionally, perched well clustered with M1233 (M1227) does not show similar levels of contamination.

+ Background from M1229, ERM(1995).

1 Maximum level was observed in 11/90. Subsequent samples in 5/94, 10/94, and 2/95 show Cd at BDL, BDL, and 2.17 ug/L in M1073. 11/90 value is not considered representative.

2 Included for cumulative risk or HI evaluation (see Table 6-14).

Table 6-7. Comparison of Residual Surface Soil Contamination at the Former ABA to RBCs and Background Concentrations

	Maximum Detected	Sample ID and	RBC (mg/kg)			Site > 2x Avg. Bkg.?	Chemical Essential Nutrient?	Site > RBCs Res. or Ind.?	Health Concern?	Reason for NFA			
Analyte	Conc. (ug/g)	Depth (ft)	Residentia	Industrial	Average Background	(Y/N)	(Y/N)	(Y/N)	(Y/N)	<2XB	<RBC	ESS Nutrient	Note Reference
Inorganic Compounds:													
Aluminum	6500	CBG- 1 (0-2 ft)	7800	200000	12478	N	N	N(N)	N	X	X		
Antimony	1.9(1.9)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	3.1	82	82	N	N	N(N)	N	X	X		
Arsenic	3.58(15)	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	0.43	3.8	5	N(Y)	N	Y(Y)/N(Y)	N	X	X		1.2.3
Barium	1.69(1200)	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	550	14000	99	N(Y)	N	N(Y)/N(N)	N	X	X		1
Beryllium	0.93(0.93)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	015	1.3	0.49	N(N)	N	Y(Y)/N(N)	N	X	X		1.2
Cadmium	1.52(1.52)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	3.9	100	1.23	N(N)	N	N(N)/N(N)	N	X	X		
Calcium	15000	CBG-1(0-2 ft)	89000	>1E+06	4317	Y	Y	N/N	N		X	X	X
Chromium	6.35*(42)	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	39	1000	16.2	N(Y)	N	N(Y)/N(N)	N	X	X		1
Cobalt	7.5*(54.2)	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	470	12000	6.93	N(Y)	N	N(N)/N(N)	N	X	X		
Copper	29.3(29.3)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	310	8200	21.36	N(N)	N	N(N)/N(N)	N	X	X		
Iron	7800(32000)	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	2300	61000	14833	N(Y)	N	Y(Y)/N(N)	N	X	X		1.2
Lead	80.2	CBG-3(0-2 ft)	400	1000	15	Y	N	N/N	N		X		
Magnesium	1280	CBC-1(0-2 ft)	22000	580000	1459	N	Y	N/N	N	X	X	X	
Manganese	1230(6690)	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	180	4700	638	N(Y)	N	Y(Y)/N(Y)	N	X	X		1.2.4
Mercury	0.025(0.025)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	2.3	61	0.11	N(N)	N	N(N)/N(N)	N	X	X		
Nickel	6.3(6.3)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	160	4100	13.1	N(N)	N	N(N)/N(N)	N	X	X		
Potassium	334	CBG-1(0-2 ft)	220000	>1E+06	695	N	Y	N/N	N	X	X	X	
Selenium	0.125(0.125)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	39	1000	0.29	N(N)	N	N(N)/N(N)	N	X	X		
Silver	0.0758	CBG-1(0-2 ft)	39	1000	BDL	Y	N	N/N	N		X		
Sodium	348	CBG-1(0-2 ft)	560000	>1E+06	225	N	Y	N/N	N	X	X	X	
Thallium	15.6(15.6)*	CBG-1(0-2 ft)[CREK-1(0-1 ft)]	0.63	16	0.9	Y(Y)	N	N(N)/N(N)	N		X		
Vanadium	80	CBG-1(0-2 ft)	55	1400	27	Y	N	Y/N	N		X		2.4
Zinc	58.9	CBG-1(0-2 ft)	2300	61000	63	N	N	N/N	N	X	X		
Organic Compounds:													
Acetone	0.025	CBG-1(0-2 ft)	780	20000	NA	NA	N	N/N	N		X		
2-Cyclohexen-1-ol	0.22	CBG-1(0-2 ft)	17	450	NA	NA	N	N/N	N		X		
2-Cyclohexen-1-one	0.11	CBG-1(0-2 ft)	17	450	NA	NA	N	N/N	N		X		
1,2-Epoxy cyclohexene	0.34	CBG-1(0-2 ft)	-	-	NA	NA	-	-	N				5
Palmitic acid	0.22	CBG-1(0-2 ft)	782	20440	NA	NA	-	N/N	N		X		
Trichlorofluoromethane	0.0029	CBG-1(0-2 ft)	2300	61000	NA	NA	N	N/N	N		X		

Note: BDL = below detection limit.  
NA = not available.  
NR = not required to be analyzed.  
RBC = risk-based concentration.  
( ) = value is the concentration in the CREK sample. The value outside the parentheses is for the CBG sample.

- \* Analyte is below detection; value shown is 1/2 detection limit for risk-based screening purposes.  
+ Background obtained from the RI conducted by Fluor Daniel for the Southern Area (1996).  
1 The CBG Sample is most representative of site exposure as the creek is not easibly accessible because brush has overgrown the creek bed, and water is sometimes present. Therefore, exposure to the creek bed is considered insignificant compared to the much higher exposure potential to the ABA grounds itself. The ABA samples (CBG) should be used to represent the overall site exposure concentration.  
2 Although the RBC for the residential scenario was exceeded, the maximum concentration was less than the Industrial RBC.  
3 Included for cumulative risk evaluation (see Table 6-12).  
4 Included for cumulative HI evaluation (see Table 6-12).  
5 An RBC could not be calculated for this constituent. No basis for comparison is available.

Source: QST.

#### **6.5.2.2 Surface Soil**

As shown in Table 6-7, 15 metals and 6 organic compounds were reported above detection limits in surface soil at the Former ABA. As shown in this table, one sample collected from the West Fork of Wolf Creek (CREK-1) exhibited the highest concentration of inorganic compounds detected at the Former ABA. This observation is expected as the creek receives surface runoff from the site. However, this single soil sample collected from the dry creek bed is not representative of potential exposure to the Former ABA study area because the creek is overgrown by brush and contains water part of the year, such that the actual exposure to the creek bed would be insignificant compared to the more routine and frequent exposure that would be reasonably expected to occur on the Former ABA grounds itself. Thus, for the objectives of the health evaluation, the maximum value detected in soil collected from the Former ABA (as denoted by CBG samples reported in Tables 54 and 6-7) was used to determine if the site soils pose any potential health concerns. The concentrations detected in the creek are important to demonstrate that the creek is a deposition area of site runoff; however, the creek does not contribute significantly to the overall exposure to the site.

When Sample CREK-1 was included in the data to be evaluated, with the exception of arsenic, barium, iron, vanadium, and manganese, all soil constituent levels were either below residential or industrial health-based levels and/or below two-times the site-specific background concentrations, or were acceptable because the constituent was considered an essential nutrient.

The 1991 RI concluded that the Former ABA was not a source of groundwater contamination (ICF, 1991).

Based on the information presented in this section (6.5.2), No Further Action cannot be considered as an appropriate response to surface soil conditions encountered at the Former ABA until a cumulative risk analysis is performed on barium, iron, vanadium, and manganese (Sec. 6.6).

#### **6.5.2.3 Subsurface Soil**

As shown in Table 6-8, 14 metals and 6 organic compounds were reported above detection limits in subsurface soil at the Former ABA. The subsurface site data presented in Table 6-8 were compared to both residential and industrial RBCs in order to be consistent with the surface soil screen. However, as the subsurface soils are deeper than 1 ft, residential exposure to these soils is unlikely. Therefore, the residential RBC was not considered relevant to subsurface soils.

Except for arsenic, the concentrations of these compounds were below the RBCs as well as two times the site-specific background soil concentrations, or the chemical was considered an essential nutrient.

Based on the information presented in this section (6.5.2.3), No Further Action cannot be considered as an appropriate response until a cumulative risk evaluation is performed on arsenic which exceeded the industrial RBC in subsurface soil (see Sec. 6.6).

### **6.5.3 Sanitary Landfill**

#### **6.5.3.1 Groundwater**

As shown in Table 6-9, 20 metals and 23 organic compounds in groundwater were reported above detection limits in monitor wells M1062, M1063, M1264, M1266, and M1279. As stated in Section 5.2.3.1, the other six monitor wells near the landfill (i.e., 003, 004, M1064, M1265, M1267, and M1280) were considered too deep to be representative monitoring points for landfill groundwater. Contamination detected at these wells is likely associated with the OBG, which is directly upgradient from the landfill. As shown in the Table 6-9, several inorganics were detected above two-times average background; however, the levels were either below RBCs or MCLs, or the chemical is considered an essential nutrient. Except for bis-2(ethylhexyl)phthalate and several explosive related compounds, all the remaining organic compounds detected were detected at levels below RBCs or MCLs. Although bis-2-ethylhexyl phthalate was detected at several wells around the Sanitary Landfill area (see Table 5-5), the contaminant has also been detected

**Table 6-8. Comparison of Residual Subsurface Soil Contamination at the Former ABA to RBCs and Background**

Analyte	Maximum	Sample ID	RBC		Subsurface	Site >	Chemical	Site >	Health	Reason for NFA			Note	
	Detected	and	(mg/kg)		Average	2x Avg.	Essential	RBCs		Health	ESS			Reference
	Conc. (ug/g)	Depth (ft)	Residential	Industrial	Background	Bkg.?	Nutrient?	Res. or Ind.?			Concern?	2XBG		
Inorganic Compounds:														
Aluminum	12000	CBG-2(10-12 ft)	7800	200000	5390	Y	N	Y/N	N		X		1	
Antimony	1.9*	All samples	3.1	82	BDL	N	N	N/N	N	X	X			
Arsenic	9.91	CBG-2(10-12 ft)	0.43	3.8	1.73	Y	N	Y/N	N				2	
Barium	220	CBG-2(10-12 ft)	550	14000	22.1	Y	N	N/N	N		X			
Beryllium	0.93*	All samples	0.15	1.3	BDL	N	N	Y/N	N	X	X		1	
Cadmium	1.52*	All samples	3.9	100	BDL	N	N	N/N	N	X	X			
Calcium	980	CBG-2(10-12 ft)	89000	>1E+06	234	Y	Y	N/N	N		X	X		
Chromium	26.6	CBG-5(10-12 ft)	39	1000	9.27	Y	N	N/N	N		X			
Cobalt	7.5*	All samples	470	12000	1.36	Y	N	N/N	N		X			
Copper	29.3*	All samples	310	8200	4.33	Y	N	N/N	N		X			
Iron	22000	CBG-2(10-12 ft)	2300	61000	5730	Y	N	Y/N	N		X		1	
Lead	15	CBG-2(10-12 ft)	400	1000	2.42	Y	N	N/N	N		X			
Magnesium	3530	CBG-2(10-12 ft)	22000	.580000	370	Y	Y	N/N	N		X	X		
Manganese	805	CBG-2(10-12 R)	180	4700	50.3	Y	N	Y/N	N		X		1	
Mercury	0.025*	All samples	2.3	61	BDL	N	N	N/N	N	X	X			
Nickel	6.3*	All samples	160	4100	3.86	N	N	N/N	N	X	X			
Potassium	752	CBG-2(10-12 ft)	220000	>1E+06	251	Y	Y	N/N	N		X	X		
Selenium	0.12*	All samples	39	1000	0.26	N	N	N/N	N	X	X			
Silver	0.0396	CBG-5(10-12 ft)	39	1000	BDL	N	N	N/N	N		X			
Sodium	578	CBG-2(10-12 ft)	560000	>1E+06	364	N	Y	N/N	N	X	X	X		
Thallium	15.6*	All samples	0.63	16	BDL	N	N	Y/N	N	X	X			
Vanadium	31	CBG-5(10-12 ft)	55	1400	16.1	N	N	N/N	N	X	X		1	
Zinc	111	CBG-2(10-12 ft)	2300	61000	9.67	Y	N	N/N	N		X			
Organic Compounds:														
Acetone	0.088	CBG-3(10-12 ft)	780	20000	NA	NA	N	N/N	N		X			
2-Cyclohexen-1-ol	0.25	CBG-2(10-12 ft)	17	450	NA	NA	N	N/N	N		X			
2-Cyclohexen-1-one	0.13	CBG-2(10-12 ft)	17	450	NA	NA	N	N/N	N		X			
1,2-Epoxy-cyclohexene	0.38	CBG-2(10-12 ft)	-	-	NA	NA	-	-	N				3	
2-Propanol	0.54	CBG-3(10-12 ft)	625	16500	NA	NA	N	N/N	N		X			
Trichlorofluoromethane	0.019	CBG-2(10-12 ft)	2300	61000	NA	NA	N	N/N	N		X			

Note: BDL = below detection limit.  
NA = not available.  
NR = not required.  
RBC risk-based concentration.

\* Analyte is below detection; value shown is 1/2 detection limit for risk-based screening purposes.

+ Background obtained from the RI conducted by Fluor Daniel for the Southern Area (1996).

1 Screening against industrial RBC is considered relevant, because soils are deeper than 1 ft; therefore, residential exposure to these soils is unlikely.

2 Included for cumulative risk evaluation (see Table 6-13).

3 An RBC could not be calculated for this constituent. No basis for comparison is available.

Source: QST.

upgradient of the Sanitary Landfill in numerous wells. In fact, M1252 and M1253, upgradient from the Sanitary Landfill, reported levels of bis-2-ethylhexyl phthalate at levels of 13 and 26 **I**g/L, respectively, in October 1994. The OBG is a documented source of groundwater contamination in the area and may also be the source of bis-2-ethylhexyl phthalate.

Elevated levels of explosive related compounds and bis-2-ethylhexyl phthalate have also been detected in monitor wells downgradient from the landfill. However, explosive-related compounds and bis-2-ethylhexyl phthalate have also been detected upgradient of the landfill, indicating that the OBG is a likely source of contamination. For this reason, bis-2-ethylhexyl phthalate, RDX, 135TNB, and 246TNT were not considered in the human health evaluation.

Because MCLs are not strictly health-based values, concentrations below MCLs were not determining factors for supporting a No Further Action recommendation. To support no further action for such an instance, these compounds must also be below two-times background or RBCs. As shown in Table 6-9, two inorganic compounds (beryllium and cadmium) and one organic compound (chloroform) were less than their MCLs, but they exceeded background or RBCs. Thus, these chemicals were included in a cumulative risk evaluation in order to determine if groundwater at this area requires further action.

#### 6.5.3.2 Surface Soil

As shown in Table 6-10, one inorganic compound (lead) was reported above detection limits while all organic compounds were below detection in surface soil. Lead was detected at 17 Ig/g, which is well below two-times background and the RBCs.

<IMG SRC 98020G1>

Based on the information presented in this section (6.5.3), No Further Action is considered an appropriate response to conditions encountered at the Sanitary Landfill. The basis for the No Further Action recommendation for each constituent detected in surface soil at the Sanitary Landfill is presented in Table 6-10.

#### 6.5.3.3 Subsurface Soil

As shown in Table 6-11, 12 inorganic compounds and one organic compound (2-propanol) were reported above detection limits in subsurface soil at the Sanitary Landfill. Except for arsenic, all inorganic compounds and the one organic, 2-propanol, were below RBCs and/or below two-times the site-specific background concentrations, or were considered an essential nutrient. Based on these results, arsenic in subsurface soil needs to be further evaluated in a cumulative risk evaluation to determine if No Further Action is an appropriate response to conditions encountered in the subsurface soils at the Sanitary Landfill.

## 6.6 Cumulative Risk Characterization

In the event that a chemical or group of chemicals fails the risk-based screening evaluation, these chemical(s) are addressed further under the same exposure scenario (e.g., residential, industrial, and/or construction worker) in a cumulative risk evaluation to determine if the risks associated with a chemical mixture within a medium pose excess risks. This evaluation is used to aid in determining whether a study site requires no further action, or whether remedial evaluation is necessary. The methods used in this risk characterization are based on those presented in EPA risk assessment guidance for human exposures (EPA, 1989, 1991a, 1995c).

### 6.6.1 Methods for Calculating Carcinogenic Risks

The potential risks associated with exposure to individual carcinogens are calculated by multiplying the daily chemical intake by the appropriate CSF as follows:

$$\text{Risk} = I * \text{CSF} \quad (6-1)$$

where: Risk = probability for an individual developing cancer under the assumed exposure conditions (unitless),  
I = daily chemical intake averaged over a lifetime of 70 years [milligrams per kilogram per day (mg/kg/day)],  
CSF = carcinogenic slope factor, expressed in (mg/kg/day)<sup>-1</sup>.



**Table 6-10. Comparison of Residual Surface Soil Contamination at the Sanitary Landfill  
to Risk-based Concentrations and Background**

Analyte	Maximum	Sample ID	RBC		Average	Site >	Chemical	Site>	Health			Reason for NFA		
	Detected	and	(mg/kg)			2x Avg.	Essential	RBCs	Concern?			ESS	Note	
	Conc. (ug/g)	Depth	Residential	Industrial		Background+	Bkg.?	Nutrient?	Res. or Ind.?	(Y/N)	(Y/N)	<2XBG	<RBC	Nutrient
Inorganic Compounds:														
Aluminum	NR	NR	7800	200000	12478	NA	N	NA	NA					
Antimony	NR	NR	3.1	82	2.2	NA	N	NA	NA					
Arsenic	NR	NR	043	3.8	5	NA	N	NA	NA					
Barium	NR	NR	550	14000	99	NA	N	NA	NA					
Beryllium	NR	NR	0.15	1.3	0.49	NA	N	NA	NA					
Cadmium	1-52*	All samples	3.9	100	1.23	N	N	N/N	N	X	X			
Calcium	NR	NR	89000	>1E+06	4317	NA	Y	NA	NA					
Chromium	6.35*	All samples	39	1000	162	N	N	N/N	N	X	X			
Cobalt	NR	NR	470	12000	6.93	NA	N	NA	NA					
Copper	NR	NR	310	8200	21.36	NA	N	NA	NA					
Iron	NR	NR	2300	61000	14833	NA	N	NA	NA					
Lead	17	LF-1(0-1ft)	400	1000	15	N	N	N/N	N	X	X			
Magnesium	NR	NR	22000	580000	1459	NA	Y	NA	NA					
Manganese	NR	NR	180	4700	638	NA	N	NA	NA					
Mercury	0.025*	All samples	23	61	0.11	NA	N	N/N	N	X	X			
Nickel	NR	NR	160	4100	13.1	NA	N	NA	NA					
Potassium	NR	NR	220000	>1E+06	695	NA	Y	NA	NA					
Selenium	NR	NR	39	1000	0.29	NA	N	NA	NA					
Silver	NR	NR	39	1000	NA	NA	N	NA	NA					
Sodium	NR	NR	560000	>1E+06	225	NA	Y	NA	NA					
Thallium	NR	NR	0.63	16	0.9	NA	N	NA	NA					
Vanadium	NR	NR	55	1400	27.4	NA	N	NA	NA					
Zinc	NR	NR	2300	61000	63	NA	N	NA	NA					

Note: NA = not available.  
NR = not reported.

\* Analyte is below detection; value shown is 1/2 detection limit for risk-based screening purposes.  
+ Background values obtained from the RI conducted by FDI in 1996.

Source: QST.

Table 6-11. Comparison of Residual Subsurface Soil Contamination at the Sanitary Landfill to Risk-based Concentrations and Background

									Site >	Chemical	Site>			Reason for NFA
	Maximum	Sample ID	RBC		Subsurface	2x Avg.	Essential	RBCs	Health			ESS	Note	
Analyte	Detected	and	(mg/kg)		Average	Bkg.?	Nutrient?	Res. or Ind.?	Concern?			Nutrient	Reference	
	Conc. (ug/g)	Depth	Residential	Industrial	Background+	(Y/N)	(Y/N)	(Y/N)	(Y/N)	<2XBG	<RBC			
Inorganic Compounds:														
Aluminum	13500	LF-1(5-9 ft)	7800	200000	5390	Y	N	Y/N	N		X		1	
Antimony	1.9*	All samples	3.1	82	BDL	N	N	N/N	N	X	X			
Arsenic	5.22	LF-1(5-9 ft)	0.43	3.8	1.73	Y	N	Y/Y	N				2	
Barium	125	LF-1(5-9 ft)	550	14000	22.1	Y	N	N/N	N	X	X			
Beryllium	0.93*	All samples	0.15	1.3	BDL	N	N	Y/N	N	X	X		1	
Cadmium	1.52*	All samples	3.9	100	BDL	N	N	N/N	N		X			
Calcium	1370	LF-2(10-12 ft)	89000	>1E+06	234	Y	Y	N/N	N		X	X		
Chromium	6.35*	All samples	39	1000	9.27	N	N	N/N	N		X			
Cobalt	7.5*	All samples	470	12000	1.36	Y	N	N/N	N		X			
Copper	258.6	LF-1(5-9 ft)	310	8200	4.33	Y	N	N/N	N		X			
Iron	13500	LF-1(5-9 ft)	2300	61000	5730	Y	N	Y/N	N		X		1	
Lead	14.2	LF-2(0-7 ft)	400	1000	2.42	Y	N	N/N	N		X			
Magnesium	1440	LF-2(10-12 ft)	22000	580000	370	Y	Y	N/N	N		X	X		
Manganese	282	LF- 1(5-9 ft)	180	4700	50.3	Y	N	Y/N	N		X		1	
Mercury	0.025*	All samples	2.3	61	BDL	N	N	N/N	N	X	X			
Nickel	6.3*	All samples	160	4100	3.86	N	N	N/N	N	X	X			
Potassium	557	LF-1(5-9 ft)	220000	>1E+06	251	Y	Y	N/N	N		X	X		
Selenium	0.12*	All samples	39	1000	0.26	N	N	N/N	N	X	X			
Silver	0.0559	LF-1(5-9 ft)	39	1000	BDL	Y	N	N/N	N		X			
Sodium	559	LF-2(10-12 ft)	560000	>1E+06	364	N	Y	N/N	N		X	X		
Thallium	15.6*	All samples	0.63	16	BDL	N	N	Y/N	N	X	X			
Vanadium	43.7	LF-2(10-12 ft)	55	1400	16.1	N	N	N/N	N	X	X			
Zinc	15.1*	All samples	2300	61000	9.67	N	N	N/N	N	X	X			
Organic Compounds:														
2-Propanol	0.0095	LF-1(5-9 ft)	625	16500	NA	NA	N	N/N	N		X			

Note: BDL = below detection limit.

\* Analyte is below detection: value shown is 1/2 detection limit for risk-based screening purposes.

+ Background values obtained from the RI conducted by FDI in 1996.

1 Screening against industrial RBC is considered relevant, because soils are deeper than 1 ft; therefore, residential exposure to these soils is unlikely.

2 Included for cumulative risk evaluation (See Table 6-13).

Source: QST.

As discussed previously, RBCs are chemical concentrations corresponding to fixed levels of risk (i.e., a hazard quotient of 0.1, or a lifetime risk of  $10^{-6}$ , whichever occurs at a lower concentration) in groundwater and soil.

RBCs are derived by actually running the above risk formula in reverse by solving for the concentration term in the intake formula, where the intake formula is as follows:

<IMG SRC 98020G2>

where:

- I = medium-specific chemical intake (mg/kg/day).
- C = chemical concentration in exposure medium [milligrams per liter (mg/L) or mg/kg].
- CR = contact rate; amount of contaminated medium contacted per unit time or even (e.g., liters/day; milligrams/day).
- EF = exposure frequency (days/year).
- ED = exposure duration (years).
- BW = body weight (kg).
- AT = averaging time; period over which exposure is averaged (days).

Because an RBC is an "acceptable" exposure concentration for a single compound present in a single medium and is derived by EPA by running the risk assessment process in reverse, cumulative risks at a study site can be determined indirectly by ratio to the chemical-specific RBCs. In other words, concentrations of chemicals failing the screening evaluation can be compared, by ratio, to the corresponding RBC to derive the site-specific risk for that chemical as follows:

<IMG SRC 98020G3>

where:

- RBC chem1 = chemical and medium-specific carcinogenic risk-based concentration (mg/L or mg/kg).
- TR chem1 = target risk associated with RBC ( $1 \times 10^{-6}$ ).
- EC chem1 = maximum detected chemical concentration at study site; (mg/L or mg/kg).
- Risk chem1 = site-specific carcinogenic risk associated with EC (unitless).

Thus, to derive a site-specific risk for each individual chemical failing the screening evaluation, the above equation is solved for Risk chem1 as follows:

<IMG SRC 98020G4>

The combined risk from exposure to multiple chemicals at a study site is evaluated by addition of resultant risks from different chemicals as follows:

<IMG SRC 98020G5>

where:

- Risk T = the sum of individual chemical risks (unitless probability), and
- Risk i = the risk estimate for the i th chemical.

Chemicals failing the residential or industrial health-based screen against surface soils were evaluated further in a cumulative risk analysis for these exposure scenarios. Because the potential exists for future worker exposure to subsurface soils at each study area, as a result of excavation/construction work at these areas, chemicals detected in subsurface soils (e.g. greater than 2 ft) were evaluated in the cumulative risk analysis using construction worker exposure assumptions (see Appendix B). Because EPA has not established a construction worker-based RBC, this RBC was calculated (see Appendix B) and used in the previous formulas to calculate construction worker cumulative risks associated potential exposure to subsurface soil.

Contaminant concentration levels that present cancer risks that fall within the range of 1 in 1,000,000 to 1 in 10,000 ( $10^{-6}$  to  $10^{-4}$ ) are generally considered to be acceptable health risks [40 Code of Federal Regulations (CFR) 300, 430:62]. EPA uses the  $10^{-6}$  to  $10^{-4}$  risk range as a "target range" within which EPA strives to manage risk as part of Superfund cleanup. Therefore, the risk results for each contamination area are summarized to highlight those individual

chemicals and media that exceed the lower bound of the risk range, or  $10^{-6}$ . The  $10^{-6}$  risk level serves as a starting point, or point-of-departure, to provide focus on those chemicals that may require further evaluation as part of subsequent studies (i.e., feasibility studies) if the cumulative site risk exceeds  $10^{-4}$ . When a cumulative carcinogenic risk to an individual under the assumed exposure conditions at the site exceeds 1 in 10,000 ( $10^{-4}$ ), CERCLA generally requires remedial action at the site (EPA, 1991c). When a cumulative risk is less than  $10^{-4}$ , action generally is not required but may be warranted if a risk-based chemical-specific standard [e.g., maximum contaminant level (MCL)] is violated, or a risk manager indicates that a lower risk level must be achieved due to site-specific reasons. In addition, remediation may be required due to the presence of unacceptable noncarcinogenic effects or ecological impacts.

#### 6.6.2 Methods for Calculating Noncarcinogenic Risks

Noncarcinogenic health risks are estimated by comparing actual or expected exposure levels to acceptable or "safe" intakes. This is accomplished by calculating a noncarcinogenic HQ. An HQ is the ratio of chronic daily intake of a contaminant to the RfD for the contaminant and is calculated as follows:

<IMG SRC 98020G6>

where:  $I$  = intake of contaminant (mg/kg/day), and  
RfD = reference dose of contaminant (mg/kg/day).

$I$  and RfD are expressed in the same units and represent the same exposure period (i.e., chronic, subchronic, or shorter term). HQs and HIs are also estimated for noncarcinogenic chemicals and potential carcinogens to obtain an assessment for the overall potential for noncarcinogenic health effects.

As discussed above for calculating cumulative carcinogenic risks, cumulative noncarcinogenic risks can be derived in the same manner as follows:

<IMG SRC 98020G7>

where: RBC chem1 = chemical and medium-specific noncarcinogenic risk-based concentration (mg/L or mg/kg).  
THQ chem1 = target HQ associated with RBC (0.1).  
EC chem1 = maximum detected chemical concentration at study site; (mg/L or mg/kg).  
HQ chem1 = site-specific HQ associated with EC (unitless).

Thus, to derive a site-specific HQ for each individual chemical failing the screening evaluation, the above equation is solved for HQ chem1 as follows:

<IMG SRC 98020G8>

The impact from the presence of multiple chemicals at a contamination area is considered additive of impacts from individual contaminants. Thus, the HI is equal to the sum of the HQs:

<IMG SRC 98020G9>

where:  $I_i$  = Intake for the  $i$ th toxicant (mg/kg/day), and  
RfD  $_i$  = reference dose for the  $i$ th toxicant (mg/kg/day).

When the cumulative HI exceeds unity (1.0), there may be concern for potential health effects. An HQ or HI equal to or less than 1.0 indicates that it is unlikely for even sensitive populations to experience adverse health effects (EPA, 1989). Any single chemical with an HQ exceeding 1 will cause the HI to also exceed 1. In addition, although the HQs for all chemicals evaluated for a particular medium and pathway may be less than 1, addition of the HQs may result in an HI that exceeds the target HI.

#### 6.6.3 Site-Specific Cumulative Risk Results

Based on the risk screening results, the Salvage Yard and Former ABA require a cumulative risk

evaluation for the surface soil while all three areas (Salvage Yard, Former ABA, and Sanitary Landfill) require a cumulative risk evaluation for subsurface soils. For groundwater, only the Former ABA and Sanitary Landfill required a cumulative risk evaluation.

Using the risk evaluation methods described previously, estimates of potential carcinogenic risks and noncarcinogenic HIs were obtained for the chemicals that failed the screening evaluation for each study site. The carcinogenic risk estimates were compared to the target cumulative risk range of  $10^{-6}$  to  $10^{-4}$ , while noncarcinogenic HIs were compared to the target HI of 1.0 (unity), above which there may be concern for potential adverse health effects. Because several chemicals detected in groundwater, surface soil, and subsurface soil failed the screening evaluation, a cumulative risk assessment was conducted for these three media.

A discussion of the human risk and HI results for each study site is presented in the following sections. Potential cumulative carcinogenic risks and noncarcinogenic HIs associated with exposure to the COCs under the future residential exposure to surface soil are presented in Tables 6-12 and 6-13 for the Salvage Yard and Former ABA, respectively. The cumulative risk construction exposure to subsurface soil at the Salvage Yard, Former ABA, and Sanitary Landfill are presented in Table 6-15. In addition, cumulative risks results associated with potential exposure to groundwater at the Former ABA and Sanitary Landfill are presented in Table 6-16.

#### **6.6.3.1 Salvage Yard**

##### **Tap Water (groundwater)**

Based on the results of the risk-based screen, none of the residual contamination in the Salvage Yard groundwater exceeded RBCs or two-times background. Therefore, a cumulative risk evaluation was not required for groundwater at this study site.

##### **Residential Scenario (surface soil)**

Based on the results of the surface soil screening evaluation, eight chemicals (all inorganic compounds) were retained for cumulative risk evaluation (See Table 6-12). As shown in Table 6-12, the cumulative carcinogenic risk calculated for residential exposure to the carcinogenic chemicals is  $1.1 \times 10^{-5}$ , which is within EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ .

According to EPA risk assessment guidance (EPA, 1989), if the cumulative HI of all COCs result in an exceedance of the target HI of 1, EPA recommends segregating the contributions of the different chemicals according to major effect, whereby individual HQs are only added within the same target organ/system. Based on target effects, the HI associated with gastrointestinal (GI) effects due to the presence of copper in surface soil is 4.2; the HI due to blood effects is 6.3 due to zinc and thallium; and the HI due to liver effects is 2 due to iron.

##### **Industrial Worker Scenario (surface soil)**

Based on the results of the surface soil screening evaluation, three compounds (beryllium, copper, and thallium) were retained for cumulative risk evaluation. Beryllium exceeded the carcinogenic-based RBC of 1.3 mg/kg, while copper and thallium exceeded the noncarcinogenic-based RBCs of 8,200 and 16 mg/kg, respectively.

As shown in Table 6-14, the cumulative carcinogenic risk calculated for industrial exposure to beryllium in surface soil is  $1.3 \times 10^{-6}$ , which is well within EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ .

For noncarcinogenic effects, the cumulative HI associated with industrial exposures to copper and thallium in surface soil is 0.4, which is below the target HI of 1, indicating that chronic adverse health effects should not result based on the exposure assumptions evaluated.

##### **Construction Worker Scenario (subsurface soil)**

Based on the results of the subsurface soil screening evaluation, one compound (arsenic) was retained for cumulative risk evaluation. Arsenic exceeded the carcinogenic-based RBC of 3.8 mg/kg with a detected concentration of 4.64 mg/kg.

As shown in Table 6-15, the cumulative carcinogenic risk calculated for construction worker exposure to arsenic in subsurface soil is  $1.2 \times 10^{-7}$ , which is below EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ .

**Table 6-12. Summary of Risks and HIs for Chemicals Detected in Surface Soil  
at Salvage Yard Exceeding RBCs Based On Residential Exposure**

Area	Analyte	Maximum Detected Concentration (ug/g)	Residential RBC		Residential Risk Characterization		
			Risk=1E-06	HQ=0.1	Site Risk	Site-HQ	Target Organ
Salvage Yard	Beryllium	1.63	0.15	NE	1.09E-05	NE	Bone
	Copper	12900	NA	310	NA	4.2	GI
	Cadmium	29.5	NA	3.9	NA	0.76	Kidney
	Chromium	75.2	NA	39	NA	0.19	Kidney
	Iron	45200	NA	2300	NA	2.0	Liver
	Lead	639	NA	400*	NA	0.28	CNS
	Zinc	2495	NA	2300	NA	0.11	Blood
	Thallium	39.1	NA	0.63	NA	6.2	Blood/liver

TOTAL 1.1E-05      +

\* The lead HQ is based on comparing the maximum site concentration to the residential screening level.

+ Individual HQs are only additive for target organs/systems; none of the target organ/system totals exceed 1.

Source: QST.

**Table 6-13. Summary of Risks and HIs for Chemicals Detected in Surface Soil at the Former ABA Exceeding RBCs Based on a Residential Exposure**

Area	Analyte	Exposure Concentration Maximum Detected (ug/g)				Residential Risk Characterization*		Target Organ/System
		Creek	Yard	CSForal	RfDoral	Site Risk	Site-HQ	
Former ABA	Arsenic	15	3.58	1.5	0.0003	1.4E-05	0.13	Skin
	Barium	1200	1.69	NA	0.07	NA	0.0002	Blood/Circulatory
	Thallium**	7.8	7.8	NA	8E-05	NA	1.0	Blood/Circulatory
	Beryllium**	0.93	0.93	4.3	0.005	6.3E-06	0.004	Bone
	Chromium**	0.42	0.42	NA	0.005	NA	0.0009	Kidney
	Iron	32000	7800	NA	0.3	NA	0.27	Liver
	Vanadium	80	80	NA	0.007	NA	0.12	GI
	Manganese	6690	1230	NA	0.023	NA	0.55	CNS
TOTAL SITE RISK						2E-05	+	

\* Site-specific exposures assumes that a child is exposed to the creek soil 20% of the total exposure; the remaining 80% of the soil exposure occurs at the remaining area.

\*\* Analyte was below detection, the concentration presented is one-half of the detection limit.

+ Individual HQs are only additive for target organs/systems; none of the target organ/system totals exceed 1.

Source: QST.

p/mlaap/rod/tab12.wm2

**Table 6-14. Summary of Risks and HIs for Chemicals Detected in Surface Soil Exceeding RBCs  
Based on Industrial Exposure**

Area	Analyte	Maximum Detected	Industrial RBC		Industrial Risk Characterization	
		Conc. (ug/g)	Risk=1E-06	HQ=0.1	Site Risk	Site-HQ
Salvage Yard	Beryllium	1.63	1.3	NE	1.2E-06	NE
	Copper	12900	NA	8200	NA	0.16
	Thallium	39.1	NA	16	NA	0.24
					TOTAL	1.2E-06
Former ABA	Arsenic	15	3.8	NE	3.9E-06	NE
	Manganese	6690	NA	4700	NA	0.14
					TOTAL	3.9E-06

Source: QST.



**Table 6-15. Summary of Risks and HIs for Chemicals Detected in Sub-Surface Soil Exceeding  
RBCs Based on Construction Exposure**

Area	Analyte	Maximum Detected	Construction RBC*		Construction	
		Conc. (ug/g)	Risk=1E-06	HQ=0.1	Site Risk	Site-HQ
Salvage Yard	Arsenic	4.64	39.5	NE	1.2E-07	NE
				TOTAL	1.2E-07	NE
Former ABA	Arsenic	9.91	39.5	NE	2.5E-07	NE
				TOTAL	2.5E-07	NE
Sanitary Landfill	Arsenic	5.52	39.5	NE	1.4E-07	NE
				TOTAL	1.4E-07	NE

\* Derived based on exposure assumptions presented in Appendix B-1.

Source: QST.

**Table 6-16. Summary of Risks and HIs for Chemicals Detected in Groundwater Below  
MCLs but Exceeding RBCs or Background Concentrations**

Area	Analyte	Maximum Detected Conc. (ug/L)	Tap Water RBC		Potable Use Risk Characterization	
			Risk=1E-06	HQ=0.1	Site Risk	Site HI
Former ABA	Beryllium	0.65	0.016	NE	4.1E-05	NE
	Cadmium	3.14	NA	1.8	NA	0.17
	Chromium	36.1	NA	18	NA	0.20
	Bis-2-ethylhexylphthalate	5.7	4.8	NE	1.2E-06	NE
	Nitrobenzene	0.596	NA	0.34	NA	0.18
	1,3,5-Trinitrobenzene	0.285	NA	0.18	NA	0.16
TOTAL					4.2E-05	0.71
Sanitary Landfill	Beryllium	1.54	0.016	NE	9.6E-05	NE
	Cadmium	4.08	NE	1.8	NA	0.23
	Bis-2-ethylhexylphthalate	52	4.8	NE	1.1E-05	NE
	Chloroform	2.6	0.15	NE	1.7E-05	NE
TOTAL					1.2E-04	0.23

Source: QST.

### 6.6.3.2 Former Ammunition Burnout Area

#### Tap Water (groundwater)

Based on the results of the risk-based screen, three inorganic compounds (beryllium, cadmium, and chromium) and three organic compounds (nitrobenzene, 1,3,5-trinitrobenzene, and bis-2-ethylhexylphthalate) require cumulative risk evaluation due to their presence in groundwater at concentrations exceeding two-times background or RBCs. Thus, these chemicals were included in a cumulative risk evaluation in order to determine if groundwater at this area requires further action.

As shown in Table 6-16, the cumulative carcinogenic risk of  $4.2 \times 10^{-5}$  associated with potable use of groundwater containing beryllium and bis-2-ethylhexylphthalate at maximum concentrations of 0.65 and 5.7 Ig/L, respectively, is within EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ . For noncarcinogenic effects, the cumulative HI associated with potable use of groundwater containing cadmium, chromium, NB, and 135TNB at maximum concentrations of 3.14, 36.1, 0.506, and 0.285 Ig/L, respectively, is 0.71, which is below the target HI of 1, indicating that chronic adverse health effects should not result based on the exposure assumptions evaluated.

#### Residential Scenario (surface soil)

Based on the results of the surface soil screening evaluation, eight inorganic compounds were retained for cumulative risk evaluation (see Table 6-13). Because there are samples that represent two discrete exposure areas within the Former ABA (Ammunition Burnout Area), this area was evaluated to address the potential of a child to be exposed to both areas during play activities. Exposure was evaluated by the percent of time a child would be expected to play in the creek area versus the time spent in the remaining area that is considered to be representative of a residential yard. The conservative assumption was made that 20 percent of the exposure would be in the creek while 80 percent of the exposure time would be in the yard. As shown in Table 6-13, the cumulative carcinogenic risk calculated for residential exposure to both areas is  $2.0 \times 10^{-5}$ , which is within EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ .

According to EPA risk assessment guidance (EPA, 1989), if the cumulative HI of all COCs result in an exceedance of the target HI of 1, EPA recommends segregating the contributions of the different chemicals according to major effect, whereby individual HQs are only added within the same target organ/system. Based on target effects, none of the HIs associated with target organ/systems were above 1.

#### Industrial Worker Scenario (surface soil)

Based on the results of the surface soil screening evaluation, two chemicals were retained for cumulative risk evaluation to include arsenic and manganese. Arsenic exceeded the carcinogenic-based RBC of 3.8, while manganese exceeded the noncarcinogenic-based RBCs of 4,700 mg/kg.

As shown in Table 6-14, the cumulative carcinogenic risk calculated for industrial exposure to arsenic in surface soil is  $3.9 \times 10^{-6}$ , which is well within EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ .

For noncarcinogenic effects, the cumulative HI associated with industrial exposures to manganese in surface soil is 0.14, which is well below the target HI of 1, indicating that chronic adverse health effects should not result based on the exposure assumptions evaluated.

#### Construction Worker Scenario (subsurface soil)

Based on the results of the subsurface soil screening evaluation, one compound (arsenic) was retained for cumulative risk evaluation. Arsenic exceeded the carcinogenic-based RBC of 3.8 mg/kg with a detected concentration of 9.91 mg/kg.

As shown in Table 6-15, the cumulative carcinogenic risk calculated for construction worker exposure to arsenic in subsurface soil is  $2.5 \times 10^{-7}$ , which is below EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ .

### 6.6.3.3 Sanitary Landfill

#### Tap Water (groundwater)

Based on the results of the risk-based screen, two inorganic compounds, beryllium and cadmium,

and the organic compound, chloroform, require cumulative risk evaluation due to their presence in groundwater at less than the MCLs, but exceeding two-times background or RBCs. Thus, these chemicals were included in a cumulative risk evaluation in order to determine if groundwater at this area requires further action.

As shown in Table 6-16, the cumulative carcinogenic risk of  $1.2 \times 10^{-4}$  associated with potable use of groundwater containing beryllium, bis-2-ethylhexylphthalate, and chloroform, slightly exceeds EPA's upperbound of the cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ . For noncarcinogenic effects, the cumulative HI associated with potable use of groundwater containing cadmium at maximum concentration of 4.08 Ig/L is 0.23, which is below the target HI of 1, indicating that chronic adverse health effects should not result based on the exposure assumptions evaluated.

#### **Residential Scenario (surface soil)**

Based on the results of the surface soil screening evaluation, none of the chemicals exceeded the residential health-based screening levels; therefore, a residential cumulative risk evaluation was not required for this area.

#### **Industrial Worker Scenario (surface soil)**

Based on the results of the surface soil screening evaluation, no chemicals were retained for further cumulative risk evaluation because none of the chemicals failed the industrial soil screening evaluation. Thus, the Sanitary Landfill is not included in the cumulative risk results presented in Table 6-14.

#### **Construction Worker Scenario (subsurface soil)**

Based on the results of the subsurface soil screening evaluation, one chemical, arsenic, was retained for cumulative risk evaluation. Arsenic exceeded the carcinogenic-based RBC of 3.8 mg/kg with a detected concentration of 5.52 mg/kg.

As shown in Table 6-15, the cumulative carcinogenic risk calculated for construction worker exposure to arsenic in subsurface soil is  $1.4 \times 10^{-7}$ , which is below EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ .

### **6.7 Summary of Risk Screen and Cumulative Risk Results**

A screening evaluation was conducted to eliminate chemicals from further cumulative risk analysis, as chemicals passing the screen are not considered to contribute significantly to overall cumulative study site risks. Several chemicals detected in groundwater at two of the three study sites failed the screening evaluation, and thus groundwater, was included for further risk evaluation. In addition, several chemicals failed the soil screening evaluation for all three study sites, such that soil, both surface and subsurface, was included for further cumulative risk evaluation. Table 6-17 summarizes the results of the risk screening and cumulative risk assessment.

#### **6.7.1 Groundwater**

The groundwater screening evaluation conducted at the Salvage Yard indicated that none of the detected chemicals in groundwater failed the screening such that further cumulative risk evaluation for groundwater at this site was not required. At the Former ABA, beryllium, cadmium, chromium, bis-2-ethylhexylphthalate, NB, and 135TNB were present in groundwater above screening levels. At the Sanitary Landfill, beryllium, cadmium, and chloroform, exceeded screening levels. Based on the cumulative risk evaluation of groundwater for the Salvage Yard and Former ABA, the cumulative risks are within EPA's cumulative risk range and the cumulative HI is below 1. Based on the cumulative risk evaluation at the Sanitary Landfill, the cumulative HI is less than 1; however, cumulative risks slightly exceed  $10^{-4}$ .

**Table 6-17. Justification of No Further Action (NFA) for All Media at the Study Areas**

<b>Study Area</b>	<b>NFA Based on Screening</b>	<b>NFA Based on Cumulative Risk Assessment</b>	<b>Media Exceeding Cumulative Risk</b>
Salvage Yard	Groundwater (Residential use)	Surface Soil (Industrial)  Subsurface Soil (Construction)	Surface Soil (Residential)
Former ABA	All media failed screening and require cumulative risk assessment	Groundwater (Residential)  Surface Soil (Residential)  Surface Soil (Industrial)  Subsurface Soil (Construction)	None
Sanitary Landfill	Surface Soil (Residential)  Surface Soil (Industrial)	Groundwater (Residential)  Subsurface Soil (Construction)	None

Note: Surface soil = 0 to 2 feet; Subsurface soil = >2 feet.

Source: QST.

## **6.7.2 Soil**

### **6.7.2.1 Salvage Yard**

The screening of surface soils at the Salvage Yard indicated a total of eight metals exceeded the residential based screening levels; three metals exceeded the industrial based screening levels for surface soils; and one metal (arsenic) exceeded for subsurface soil. The results of the cumulative risk evaluation for the industrial and construction worker scenario indicate that the residual chemical concentrations in surface and subsurface soil are below or within EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ , or below the target HI of 1 for the industrial and construction worker scenario's.

Cumulative residential risk was also within EPA's cumulative target risk range. However, based on target effects, the HI associated with GI effects due to the presence of copper in surface soil in 4.2; the HI due to blood effects is 6.3 due to zinc and thallium; the HI due to liver effects is 2 due to iron.

Although the HIs associated with target organs exceed 1 for only the future residential scenario associated with surface soil (i.e., HIs range from  $<1$  to 6), these HI values have been derived based on a number of conservative assumptions regarding exposure and toxicity to ensure that the evaluation is over protective rather than under protective. Regarding toxicity, the HIs are based on the use of EPA-derived toxicity values, or RfDs, that incorporate a quantitative uncertainty.

The primary source of this uncertainty is the derivation of RfDs from animal laboratory studies due to the limited data available from clinical human studies. To ensure the protection of human health, however, EPA applies a number of uncertainty factors to the animal data to account for its use in assessing human health. The total uncertainty factors usually range from 1 to over 1,000 with the higher uncertainties associated with studies that are less confident or are associated with animal effects that are not readily extrapolated to humans.

As previously stated, eight metals in surface soils exceeded screening levels (beryllium, cadmium, chromium, copper, iron, lead, thallium, and zinc). Four of these metal contributed to an exceedance of a target HI of 1 in a target organ/system (copper, iron, thallium, and zinc), while the other four metals (beryllium, cadmium, chromium, and lead) were determined to be present at concentrations that did not warrant further concern.

The uncertainty factors applied to the toxicity values for the four metals that contributed to an exceedance of a target HI of 1 in a target organ/system are 2 (for copper), and 3 (for zinc), 1,000 (for iron), and 3,000 (for thallium). In addition to the uncertainty factor of 2 for copper, additional uncertainty is associated with the HI calculation because the RfD used for copper was not derived by EPA but was back-calculated from the maximum contaminant level goal (MCLG) for copper in drinking water. Thus, the additional uncertainty for copper is related to applying a RfD based on groundwater consumption to an exposure pathway based on soil ingestion.

In summary, although several metals contributed to an exceedance of a target HI of 1, the uncertainty factors incorporated in the human toxicity values suggest that exposure to soils at the Salvage Yard may not result in any adverse systemic effects.

### **6.7.2.2 Former ABA**

The screening of surface soils at the Former ABA indicated a total of five metals exceeded the residential based screening levels (an additional three were added because detection limits were greater than screening levels); two metals exceeded the industrial based screening levels for surface soils; and one metal (arsenic) exceeded for subsurface soils. The results of the cumulative risk evaluation indicate that the residual chemical concentrations in surface and subsurface soil are below or within EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ , for all three scenarios evaluated. In addition, the noncarcinogenic evaluation indicates that HIs for target effects are below 1 for residential exposure and cumulative HIs for industrial and construction workers are less than 1.

### **6.7.2.3 Sanitary Landfill**

The Screening of surface soils at the Sanitary Landfill indicated no metals exceeded the residential or industrial based screening levels in surface soils. One metal, arsenic, exceeded the subsurface soil screening level. Based on a residential land use, however, the results of the cumulative risk evaluation indicated that the residual arsenic concentration in subsurface soil is below EPA's cumulative target risk range of  $10^{-6}$  to  $10^{-4}$ , based on a more realistic construction scenario.

## 7.0 Basis for NFA Recommendation

As discussed in Section 6.0, the majority of constituents detected in the various media at the Salvage Yard, Former ABA, and Sanitary Landfill passed the Health Evaluation screening process and therefore, no further action is required for these constituents. If a COPC could not be recommended for NFA based on the health screen, the COPC was retained to assess cumulative risks. Based on the health based screening and results of the cumulative risks, an NFA recommendation was justified for all areas, with the exception of the residential scenario use of groundwater at the Sanitary Landfill and soil at the Salvage Yard.

### Groundwater at the Sanitary Landfill

As previously stated, if a chemical passes the screening process (the cumulative carcinogenic risk is less than  $10^{-4}$  and the cumulative non-carcinogenic risk is less than 1), no further action is required. However, when a cumulative risk threshold is exceeded, it does not necessarily mean that remedial action is required. Other factors and information need to be considered in addition to cumulative risk.

The cumulative risk at the Sanitary Landfill is  $1.1 \times 10^{-4}$ . Beryllium contributes approximately 87 percent of the total potential carcinogenic risk estimated for this site. The maximum detected concentration of beryllium was 1.54  $\mu\text{g/g}$ . The MCL (i.e., the primary drinking water standard) for beryllium is 4  $\mu\text{g/L}$  and corresponds to a carcinogenic risk of  $2.5 \times 10^{-4}$ . MCLs are promulgated by law. When an MCL is defined, numerous factors such as health effects and costs for compliance are considered. The fact that the MCL for beryllium exceeds the upper-bound risk of  $1 \times 10^{-4}$  shows that it is not practicable to achieve the  $1 \times 10^{-4}$  risk concentration for beryllium.

The MCLs for the COPCs evaluated for cumulative risk at the Sanitary Landfill are:

- Beryllium - 4  $\mu\text{g/L}$ ,
- Cadmium - 5  $\mu\text{g/L}$ ,
- Chloroform - 100  $\mu\text{g/L}$  (based on total halocarbons).

The maximum concentrations for the Sanitary Landfill groundwater are less than the above MCLs for beryllium, cadmium, and chloroform.

Bis-2-ethylhexyl phthalate, RDX, 135TNB, and 246TNT were detected at elevated levels in groundwater downgradient from the Sanitary Landfill. However, these constituents were also detected upgradient as well. These constituents have been detected in monitor wells for the OBG and will be addressed with the OBG plume as part of the site-wide groundwater operable unit and the southern study area operable unit.

When considering the above factors (cumulative risk, risks associated with MCLs, the fact that some COPCs in groundwater at the Sanitary Landfill are less than MCLs, and upgradient sources of contamination), a no further action recommendation for groundwater at the Sanitary Landfill is appropriate.

### Soil at the Salvage Yard

Although the HI of 1 was exceeded under the residential scenario for surface soil at the Salvage Yard, the residential scenario is not considered applicable to MLAAP. Since MLAAP currently fulfills a critical mission that will be necessary as part of future Army operations, and it is Army practice to clean up to the current land use scenario, no clean-up decisions were based on the future residential use scenario. Given this, and considering that the industrial use and construction use scenario's did not pose unacceptable risks, a no further action recommendation for surface soil at the Salvage Yard is appropriate.

Access to the Salvage Yard is restricted by fence and gate. If, in the future, MLAAP would be subject to base closure, or access to the Salvage Yard became unrestricted, site-related risk would be re-evaluated in accordance with DoD base closure policy (10 U.S.C. 2687 and NOTE).



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## **Appendix A**

### **Responsiveness Summary**

The purpose of the Responsiveness Summary is to provide the public with a summary of citizen comments, concerns, and questions about the Salvage Yard, Former Ammunition Burnout Area (ABA), and Sanitary Landfill.

The Final Proposed Plan for the Salvage Yard, Former ABA, and Sanitary Landfill was released to the public in November 1997. A public availability session announcement for the meeting was published in the Milan Mirror Exchange and Jackson Sun in November 1997.

The public availability session was held on December 4, 1997, at the Tom C. McCutchen Agricultural Museum. At this meeting, representatives of the Army, EPA, and TDEC were available to summarize the information presented in the Proposed Plan, discuss the rationale for selecting No Further Action as the preferred alternative, and discuss any site-related issues raised by the public.

No written comments were received during the 30-day public comment period. In addition, no verbal comments were presented during the December 4, 1997 public availability session.

## Appendix B

### Appendix B-1

Health Based-Screening Equations and Methodologies

### Appendix B-2

Exclusion of Inhalation and Dermal Exposure Pathways as Insignificant

### Appendix B-3

Toxicity Assessment

**Appendix B-1**  
**Health Based - Screening Equations and Methodologies**

**RBC SAMPLE CALCULATIONS FOR GROUNDWATER,  
SURFACE SOIL, AND SUBSURFACE SOIL**

**GROUNDWATER RBC**

Sample calculations for deriving both a noncarcinogenic and carcinogenic-based groundwater RBCs are provided in the following sections.

**Carcinogenic Effects**

The generalized formula for calculating RBCs based on carcinogenic effects is as follows:

<IMG SRC 98020H>

where:

- RBC gw = Risk-based concentration for groundwater (ug/L)
- TR = target risk (unitless).
- BW a = adult body weight (kg).
- AT c = averaging time for carcinogenic exposures (days per lifetime).
- EF = exposure frequency (days/year).
- IFA adj = age-adjusted tap water ingestion rate (L-yr/kg-day).
- CSF o = oral cancer slope factor [(mg/kg/day) <sup>-1</sup>].
- CSF i = inhalation cancer slope factor [(mg/kg/day) <sup>-1</sup>]
- IFW adj = age-adjusted inhalation factor (L-yr/kg-day).
- FC = factor to convert groundwater concentration from mg/L to ug/L.
- K = volatilization factor (L/m<sup>3</sup>).

Substituting the relevant exposure assumptions and toxicity dose-response values into equation the groundwater carcinogenic-based RBC for chloroform is calculated as follows:

<IMG SRC 98020H1>

where:

- TR = 1E-06.
- BW = 70 kg.
- AT c = 25550 days/lifetime.
- EF = 350 days/year.
- ED = 30 yrs.
- IR gw = 2 L/day.
- CSF o = 0.0061 (mg/kg/day) <sup>-1</sup>
- CSF i = 0.081 (mg/kg/day) <sup>-1</sup>
- K = 0.5 L/m<sup>3</sup>.

## GROUNDWATER RBC (continued)

All exposure factors and toxicity factors were provided by the EPA Region III Risk-Based Concentration Table (EPA, 1997). For nonvolatile compounds, such as arsenic, do not address the volatilization portion of the RBC equation which is  $CSF_i \times K \times IFA_{adj}$ .

### Noncarcinogenic Effects

The generalized formula for calculating groundwater RBCs based on noncarcinogenic effects is as follows:

<IMG SRC 98020H2>

where:

- RBC gw = noncarcinogenic risk-based concentration (ug/L).
- THQ = target hazard quotient (0.1).
- BW a = adult body weight (kg).
- AT n = averaging time for noncarcinogenic exposures (ED x 365 days/year).
- EF = exposure frequency (days/year).
- ED = exposure duration (years).
- IRW a = intake rate for groundwater (L/day).
- RfD o = oral reference dose (mg/kg/day).
- RfD i = inhalation reference dose (mg/kg/day).
- IRA a = inhalation rate (m<sup>3</sup>/day).
- FC = factor to convert groundwater concentration in mg/L to ug/L.
- K = volatilization factor (L/m<sup>3</sup>).

Substituting the relevant exposure assumptions and toxicity dose-response values into equation (3), the groundwater noncarcinogenic-based RGO for ethylbenzene is calculated as follows:

<IMG SRC 98020H3>

where:

- THQ = 0.1.
- BW = 70 kg.
- AT n = 30 years x 365 days/year or 10950 days.
- EF = 350 days/year.
- ED = 30 years.
- IRW a = 2 L/day.
- RfD o = 0.1 mg/kg/day.
- RfD i = 0.29 mg/kg/day.
- IRA a = 20 m<sup>3</sup>/day.
- FC = 1000 ug/mg.
- K = 0.5 L/m<sup>3</sup>.

## SURFACE SOIL RBC

Sample calculations for deriving both a carcinogenic and noncarcinogenic-based RBCs in soil are provided in the following sections. Samples were provided for the three scenarios evaluated in the risk-based Screen to include: residential, industrial, and construction.

### Residential-Carcinogenic

The generalized formula for calculating a residential-based RBC based on carcinogenic effects is as follows:

<IMG SRC 98020H4>

Where:

TR = target risk (unitless).  
BW a = adult body weight (kg).  
AT c = averaging time for carcinogenic exposures (days per lifetime).  
EF = exposure frequency (days/year).  
FC = soil conversion factor (kg/mg).  
CSF o = oral cancer slope factor [(mg/kg/day) <sup>-1</sup>].  
IFS adj = age-adjusted intake rate for soil (mg-yr/kg-day).

Substituting the relevant exposure assumptions and toxicity dose-response values into equation the soil residential carcinogenic-based RBC for arsenic is calculated as follows:

<IMG SRC 98020H5>

where:

TR = 1E-06.  
BW = 70 kg.  
FC = 1,000,000 mg/kg.  
CSF o = Oral cancer slope factor [(mg/kg/day) <sup>-1</sup>].  
IFS adj = 114..29 (mg-yr/kg-day).  
AT c = 25550 days/lifetime.  
ED = 30 yrs.

Note, all exposure factors and toxicological factors were provided by the EPA Region III Risk-Based Concentration Table (EPA, 1997).

## SURFACE SOIL RBC (continued)

### Residential-Noncarcinogenic

The generalized formula for calculating residential soil RBCs based on noncarcinogenic effects is as follows:

<IMG SRC 98020H6>

where:

- RBC a = noncarcinogenic risk-based concentration (ug/L).
- THQ = target hazard quotient (0.1).
- BW c = body weight of a child (kg).
- AT n = averaging time for noncarcinogenic exposures  
(exposure duration x 365 days/year);(days/years).
- EF = exposure frequency (days/year).
- ED = exposure duration for a child (years).
- IRS c = intake rate for soil (mg/day).
- RfD o = oral reference dose (mg/kg/day).
- FC = factor to convert mg to kilograms.

Substituting the relevant exposure assumptions and toxicity dose-response values into equation (3), the soil residential noncarcinogenic-based RBC for aluminum is calculated as follows:

<IMG SRC 98020H7>

where:

- THQ = 0.1.
- BW = 15 kg.
- AT n = 6 years x 365 days/year or 2190 days.
- EF = 350 days/year.
- ED = 6 years.
- IRS c = 200 mg/day.
- RfD o = 1 mg/kg/day.
- FC = 1,000,000 mg/kg.

## SURFACE SOIL RBC (continued)

### Industrial-Carcinogenic

The generalized formula for calculating a industrial-based RBC based on carcinogenic effects is as follows:

<IMG SRC 98020H8>

Where:

TR = target risk (unitless).  
BW a = adult body weight (kg).  
AT c = averaging time for carcinogenic exposures (days per lifetime).  
EF = exposure frequency (days/year).  
ED = exposure duration (years).  
FC = soil conversion factor (kg/mg).  
CSF o = oral cancer slope factor [(mg/kg/day) <sup>-1</sup>].  
IRS a = adult intake rate for soil (mg/day).  
FS = fraction of contaminated soil ingested.

Substituting the relevant exposure assumptions and toxicity dose-response values into equation the industrial soil carcinogenic-based RBC for arsenic is calculated as follows:

<IMG SRC 98020H9>

where:

TR = 1E-06.  
BW a = 70 kg.  
AT c = 25550 days/lifetime.  
EF = 250 days/year.  
ED = 25 yrs.  
FC = 1,000,000 mg/kg.  
CSF o = oral cancer slope factor [(mg/kg/day) <sup>-1</sup>].  
IRS a = 100 (mg/day).  
FS = 0.5.



## SURFACE SOIL RBC (continued)

### Industrial-Noncarcinogenic

The generalized formula for calculating industrial soil RBCs based on noncarcinogenic effects is as follows:

<IMG SRC 98020I>

where: RBC a = noncarcinogenic risk-based concentration (mg/kg).  
THQ = target hazard quotient (0.1).  
BW a = body weight of an adult (kg).  
AT n = averaging time for noncarcinogenic exposures (exposure duration x  
365 days/year);(days/years).  
EF = exposure frequency (days/year).  
ED = exposure duration for an adult (years).  
IRS a = intake rate for soil (mg/day).  
RfD o = oral reference dose (mg/kg/day).  
FS = fraction of contaminated soil ingested.  
FC = factor to convert mg to kilograms.

Substituting the relevant exposure assumptions and toxicity dose-response values into equation, the soil industrial noncarcinogenic-based RBC for aluminum is calculated as follows:

<IMG SRC 98020I1>

where: THQ = 0.1.  
BW a = 70 kg.  
AT n = 25 years x 365 days/year or 9,125 day.  
EF = 250 days.  
ED = 25 years.  
IRS a = 100 mg/day.  
RfD o = 1 mg/kg/day.  
FS = 0.5.  
FC = 1,000,000 mg/kg.

## SUBSURFACE SOIL RBC

EPA Region 4 has not prescribed default exposure factors for a construction worker scenario, however, they do recommend that this scenario be addressed if there are any plans in the future for a site to be excavated, and thus, could expose a future worker to subsurface soils. EPA Region-wide RAGS Supplements (EPA, 1991) suggests that a soil ingestion rate of 480 mg/day be used for construction scenarios, however, the guidance does not prescribe exposure durations nor frequencies due to that fact that the work is "usually short-term and is ... dictated by the weather. Thus, exposure frequency would generally be less than one year and exposure duration would vary according to site-specific construction/maintenance plans. "(EPA, 1991).

### Construction Worker-Carcinogenic

Based on the available EPA guidance, the generalized formula for calculating construction soil RBCs based on carcinogenic effects is as follows:

<IMG SRC 98020I2>

Where:

TR = target risk (unitless).  
BW a = adult body weight (kg).  
AT c = averaging time for carcinogenic exposures (days per lifetime).  
EF = exposure frequency (days/year).  
ED = exposure duration (years).  
FC = soil conversion factor (kg/mg).  
CSF o = oral cancer slope factor [(mg/kg/day) <sup>-1</sup>].  
IRS a = adult intake rate for soil (mg/day).

Substituting the relevant exposure assumptions and toxicity dose-response values into equation the industrial soil carcinogenic-based RBC for arsenic is calculated as follows:

<IMG SRC 98020I3>

where:

TR = 1E-06.  
BW a = 70 kg.  
AT c = 25550 days/lifetime.  
EF = 250 days/year.  
ED = 0.25 yrs.  
FC = 1,000,000 mg/kg.  
CSF o = oral cancer slope factor [(mg/kg/day) <sup>-1</sup>].  
IRS a = 480 mg/day.

## SUBSURFACE SOIL RBC (continued)

### Construction Worker-Noncarcinogenic

The generalized formula for calculating construction soil RBCs based on noncarcinogenic effects is as follows:

<IMG SRC 98020I4>

where:

- RBC<sub>s</sub> = noncarcinogenic risk-based concentration (mg/kg).
- THQ = target hazard quotient (0.1).
- BW<sub>a</sub> = body weight of an adult (kg).
- AT<sub>n</sub> = averaging time for noncarcinogenic exposures (exposure duration x 365 days/year)/(days/year).
- EF = exposure frequency (days/year).
- ED = exposure duration for an adult (years).
- IRS<sub>a</sub> = intake rate for soil (mg/day).
- RfD<sub>o</sub> = oral reference dose (mg/kg/day).
- FC = factor to convert mg to kilograms.

### Construction Worker-Noncarcinogenic

Because none of the noncarcinogenic chemicals in subsurface soil exceeded a noncarcinogenic-based RBC, a cumulative HI for this scenario was not evaluated at any of the three study sites.

**Appendix B-2**  
**Exclusion of Inhalation and**  
**Dermal Exposure Pathways as Insignificant**

**Demonstration that the Inhalation and Dermal Exposure Pathway**  
**Associated with Arsenic is Insignificant**

To demonstrate that the inhalation and dermal exposure routes contribute insignificantly to cumulative soil risks, an RBC was developed considering all three routes of exposure and compared to the RBC based solely on the oral route of exposure. The formula for calculating a RBC for all three routes of exposure is presented below:

<IMG SRC 98020I5>

Where:

- TR = target risk ( $1 \times 10^{-6}$ ).
- BW = body weight (70 kg)(EPA, 1995a).
- AT carc = averaging time for carcinogenic exposures (70 yrs x 365 days/yr=25,550 days).
- EF = exposure frequency (250 days/yr)(EPA, 1995a).
- ED = exposure duration (0.25 yrs)(site-specific assumption that construction/excavation lasts 3 months).
- CF = soil conversion factor ( $1 \times 10^{-6}$  kg/mg).
- CSFo = oral cancer slope factor [ $(1.5 \text{ mg/kg/day})^{-1}$ ](EPA, 1996)
- CSFd = dermal cancer slope factor [ $\text{CSFo/gastrointestinal absorption of 95\%} = (1.6 \text{ mg/kg/day})^{-1}$ ].
- CSFi = inhalation cancer slope factor [ $(15 \text{ mg/kg/day})^{-1}$ ](EPA, 1996)
- IRso = intake rate for soil (480 mg/day)(EPA, 1991a).
- SA = skin surface area available for soil contact; 50th percentile for forearms and hands for an adult male (2,300 cm<sup>2</sup>)(EPA, 1990).
- AF = soil-to-skin adherence factor (1.0 mg/cm<sup>2</sup>)(EPA, 1995a).
- ABS = chemical-specific absorption factor (unitless).
- IRa = inhalation rate (0.83 m<sup>3</sup>/hr)(EPA, 1990).
- ET = exposure time (8 hrs/day)(EPA, 1990)
- PEF = particulate emission factor ( $4.63 \times 10^9$  m<sup>3</sup>/kg)(EPA, 1991b).

Based on a three month exposure duration (0.25 yr) and an 8 hour workday whereby a worker is in contact with soil orally, dermally, and via inhalation, a  $1 \times 10^{-6}$  risk-based level of 39.7 mg/kg for arsenic was calculated. The carcinogenic RBC calculated based only on oral exposure is using the same formula above but deleting the dermal and inhalation exposure pathway and the oral carcinogenic-based RBC for a construction worker remains at 39.7 mg/kg as shown below:

<IMG SRC 98020I6>

## Appendix B-3

### TOXICITY ASSESSMENT

The toxicity assessment section of an RA weighs the available evidence regarding the potential for a particular chemical to cause adverse effects in exposed individuals, and provides an estimate of the extent of exposure and possible severity of adverse effects. The assessments used to develop toxicity values consist of two steps: (1) hazard identification, and (2) dose-response assessment. The hazard identification determines the potential adverse effects associated with exposure to a chemical along with the types of potential health effects involved. In the dose-response assessment, quantitation of the toxicity values and estimation of reference dose values are performed.

The COPCs at the site are well studied, toxicological assessments and technical criteria documents prepared by EPA served as the primary information sources on pharmacokinetics, and human health effects. Toxicity factors [reference doses (RfDs)] presented in this section reflect the most current toxicological information available from EPA (IRIS, 1996; EPA, 1995a, EPA, 1995b) and other sources. These factors are used in conjunction with default exposure factors to develop health-based screening levels for evaluating risk.

An reference dose (RfD) is an estimate (with uncertainty spanning approximately an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects if experienced continuously during a lifetime and is the toxicity value most often used to evaluate the noncarcinogenic impacts from exposure to chemicals. RfDs are specific to the route of exposure (i.e., an inhalation RfD is used for inhalation exposure), critical effect (developmental or systemic), and the length of exposure evaluated. Chronic RfDs are specifically developed to be protective against long-term exposure to a chemical. Subchronic RfDs are developed to characterize potential noncarcinogenic effects associated with shorter-term exposures. The derivation procedure for an RfD can be found in RAGS, Part A (EPA, 1989b) or other technical guidance documents for criteria development.

A CSF and the accompanying WoE determination are the toxicity data most commonly used to evaluate potential human carcinogenic risks. The methods used by EPA to derive CSFs or unit risks are described in RAGS, Part A (EPA, 1989b). For carcinogens, EPA usually assumes a non-threshold response, or that at every dose level of a carcinogen there is some amount of adverse response; no dose is believed to be risk-free. For carcinogens, EPA uses a 2-part evaluation; determination of a WoE classification and calculation of a CSF.

Generally, a CSF is a plausible upperbound estimate of the probability of a response per unit intake of a chemical over a lifetime. Toxicity to carcinogens can be expressed in several ways. The CSF is usually the 95 percent upper confidence limit (UCL 95) of the slope of the dose-response curve and is expressed as (mg/kg/day)<sup>-1</sup>. Toxicity values for carcinogenic effects can also be expressed as risk per unit concentration of the substance in the medium of exposure, referred to as unit risks.

Site COPC exposure levels are not at high enough levels to warrant an acute or a subchronic toxicity evaluation. Chronic exposures are evaluated. A list of all the criteria used for the relative risk calculations is included in Table 6-1. The RfDs and CSFs presented in this table are the values provided in IRIS (1996), HEAST (EPA, 1995a) and other sources, and have been rounded to two significant figures.

## **APPENDIX B**

### **REFERENCES**

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